# Chapter Ind 50

## SCOPE OF BUILDING CODE


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**Ind 50.001 Application.** (1) NEW BUILDINGS AND ADDITIONS. This code shall apply to all new buildings, structures, and also to additions to existing buildings and structures, except as in section Ind 50.03.

(2) EXISTING BUILDINGS. Buildings and structures erected prior to the effective date of the first building code (October 9, 1914) shall comply with the general orders on existing buildings, issued by the industrial commission.

**Ind 50.01 Alterations.** This code shall apply to all alterations in any building or structure which affects the structural strength, fire hazard, exits or lighting of any new or existing building or structure. This code does not apply to ordinary non-structural changes or minor repairs necessary for the maintenance of any building or structure.

History: 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 50.02 Change of use.** (1) When the use of a building or structure is changed and the requirements for the new use are more stringent than those for the previous use then such building or structure shall be made to comply with the requirements for the new use as provided in this code.

(2) If, upon an inspection of a building or structure, it is found that its use was changed since the effective date of the first building code (October 9, 1914) and that it does not comply with the requirements of the building code in effect at the time of such change, it shall then be made to comply with the code requirements in effect at the time of change in use.

**Ind 50.03 Exemption from code requirements.** This code does not apply to the following buildings:

(1) Dwellings, and outbuildings in connection therewith, such as barns and private garages.

(2) Apartment buildings used exclusively as the residence of not more than 2 families.

(3) Buildings used exclusively for agricultural purposes which are not within the limits of a city or an incorporated village.

(4) Temporary buildings or sheds used exclusively for construction purposes, not exceeding 2 stories in height, and not used for living quarters.

**Ind 50.04 Local regulations.** This code shall not limit the power of cities, villages and towns to make, or enforce, additional or more stringent regulations, provided the same do not conflict with this code or with any other rule of the industrial commission.

**Enforcement**

**Ind 50.10 Approval of plans and specifications.** (1) Complete plans and specifications for all buildings and structures in the following classifications shall be submitted to the industrial commission for approval before letting contracts or commencing work.

(a) Theaters and assembly halls.
(b) Schools and other places of instruction.
(c) Apartment buildings, hotels and places of detention.
(d) Hazardous occupancies.
(e) Factories, office and mercantile buildings.

(2) The submission of plans and specifications for factories, office and mercantile buildings containing less than 25,000 cubic feet total volume is waived, providing they have no floor or roof spans greater than 30 feet and are not more than 2 stories high. Buildings for which the submission of plans and specifications is waived shall comply with the requirements of this code.

(3) All plans shall be submitted in triplicate and work shall not be started until plans are approved. The following data shall be a part of, or shall accompany, all plans submitted for approval.

(a) The location and grades of adjoining streets, alleys, lot lines and any other buildings on the same lot or property.
(b) Name of owner.
(c) Intended use or uses of all rooms, and the number of persons to be accommodated therein.
(d) Assumed bearing value of soil.
(e) Assumed live loads.
(f) Assumed dead loads, itemized.
(g) Assumed unit stresses for structural materials.
(h) Stress diagrams for all trusses.
(i) Typical calculations for slabs, beams, girders and columns.

(4) Complete structural calculations shall be furnished upon request of the industrial commission or other authorized approving official. All plans and specifications shall be sealed or stamped by a registered architect or registered professional engineer except that plans for buildings having a total volume of less than 50,000 cubic feet shall be signed by the designer.

(5) This section shall apply to additions and alterations, as well as to new buildings, and shall also apply to all cases where there is a change of occupancy or use of a building.

(6) In cities where plans are examined, and building permits are issued, by a city building official in a manner approved by the industrial commission, additional approval by the industrial commission is not required.

(7) This section shall not apply to sanitary appliances, such as water supply and sewage disposal systems, chemical and septic toilets and similar equipment which shall be submitted for approval and installed in accordance with the regulations of the state board of health.

(8) After being approved, plans and specifications shall not be changed in any respect which may involve any provisions of this code, except with the written consent of the approving official.

(a) The approval of a plan or specification is not to be construed as the assumption of any responsibility for the design.

**History:** 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 50.11 Evidence of approval.** The architect, professional engineer, builder or owner shall keep at the building one set of plans bearing the stamp of approval.

**Ind 50.12 Approval of materials, methods and devices.** All materials, methods of construction and devices designed for use in the construction, alteration or equipment of buildings or structures under this code and not specifically mentioned in this code shall not be so used until approved in writing by the industrial commission, except sanitary appliances, which shall be approved in accordance with the state plumbing code issued by the state board of health. The data, tests and other evidence necessary to prove the merits of such material, method of construction or device shall be determined by the industrial commission.

(3) The industrial commission will accept roof coverings for different fire-resistance values as established by, and if installed according to, the requirements of the Underwriters' Laboratories.

*Note:* The Underwriters' Laboratories "List of Inspected Materials" is obtainable from the Fire Insurance Rating Bureau and Fire Insurance Agencies.

(4) The industrial commission will approve, subject to the provisions of this section, any roof covering which has developed the required fire-resistance in tests as specified in the "Standard Specifications of Fire Tests of Building Construction and Materials" (A.S.T.M. Designation C19–33) when conducted by a nationally recognized testing laboratory.

**Ind 51.08 Occupancy separations.** (1) When a building is used for more than one occupancy purpose, each part of the building comprising a distinct occupancy division shall be separated from any other occupancy division as provided for under the occupancy requirements of this code.

(2) Occupancy separations shall be classed as "Absolute", "Special" and "Ordinary" and shall apply to both horizontal and vertical separations.

(a) An absolute occupancy separation shall have no openings therein and shall be of not less than 4-hour fire-resistive construction as specified in sections Ind 51.05 and Ind 51.06.

(b) A special occupancy separation shall be of not less than 3-hour fire-resistive construction as specified in sections Ind 51.05 and Ind 51.06. All openings in walls forming such separation shall be protected on each side thereof by self-closing fire-resistive doors as specified in section Ind 51.09, and such doors shall be kept normally closed. The total width of all openings in any such separating wall in any one story shall not exceed 25% of the length of the wall in that story and no single opening shall have an area greater than 120 square feet.

1. All openings in floors forming this type of separation shall be protected by vertical enclosures extending above and below such openings. The walls of such vertical enclosures shall be of not less than 2-hour fire-resistive construction as specified in section Ind 51.05 and all openings therein shall be protected on one side thereof by self-closing one-hour fire-resistive doors as specified in section Ind 51.09 and such doors shall be kept normally closed.

(c) An ordinary occupancy separation shall be of not less than one-hour fire-resistive construction as specified in sections Ind 51.05 and Ind 51.06. All openings in such separations shall be protected by self-closing fire-resistive doors as specified in section Ind 51.001 and such doors shall be kept normally closed.

**Ind 51.09 Fire-resistive doors.** (1) Fire-resistive doors have no time resistance rating established by governmental agencies. It will be the policy of the industrial commission to approve, subject to the provisions of this section, any door given a rating by the Underwriters' Laboratories in their "Building Materials List" as class A, B, C, D and E having varying degrees of resistance, and suitable for various locations.

(2) Where fire-resistive doors are required, class A doors, or equal, shall be used for all openings in 3 and 4 hour fire-resistive walls. Class B doors, or equal, shall be used for all openings in 2-hour walls. Doors for elevator shafts shall be of class B type or equal. Class C doors, or equal, shall be used in openings in corridor partitions in fire-resistive buildings and for openings in one-hour fire-resistive partitions except that wood doors of solid flush type, 1¾ inches thick may be used in such buildings which are less than 85 feet in height. Class D and E doors, or better, shall be used in outside wall openings where required for fire escapes.

(3) All required fire-resistive doors shall be equipped with a self-closing device.

History: 1-2-56; r. and recr. Register, September, 1959, No. 45, eff. 10-1-59; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 51.10 Fire-resistive windows.** (1) Windows shall be of a design approved by the industrial commission for the intended use as provided under occupancy classifications. The term "window" in this section shall include the frame, sash and all other parts of a complete assembly. Approved wire glass ¼ inch in thickness shall be used for glazing.

(2) Windows shall be limited to sizes for which effective fire-resistance has been demonstrated by actual fire test, and which in no case exceed 84 square feet in area and 12 feet in greatest dimension. Such windows may be combined in multiple assemblies when separated by approved metal mullions, which shall be considered non-bearing.

(3) Individual glass lights shall not exceed 720 square inches in area, and 54 inches in vertical and 48 inches in horizontal dimension.

*Note:* It will be the policy of the industrial commission to approve, subject to the provisions of this section, any window bearing the inspection manifest of the Underwriters' Laboratories for the situation of installation.

**Ind 51.11 Glass block.** (1) USE. Approved glass block may be used in non-load bearing panels in walls where ordinary glass will be permitted, unless specifically prohibited by occupancy requirements of this code.

(2) INSTALLATION. Glass block panels shall not exceed 144 square feet in unsupported area, with a maximum height of 20 feet and a maximum width of 20 feet. The horizontal and vertical mortar joints between each block shall be composed of one part of Portland cement, one part of lime and 4 parts of sand, or its equivalent.

(a) All panels over 6 feet in width shall be supported on each side by chases, not less than 1½ inches in depth, of metal or other incombustible material.

(b) Approved continuous metal bond ties shall be provided in each horizontal mortar joint for block of nominal 12 x 12 inch size and in at least every third joint for block of smaller dimension.

(c) Provision shall be made in all panels for expansion, using approved expansion material not less than ½ inch thick for heads and lintels and not less than ¼ inch thick for jambs.

**Ind 51.12 Height of building.** The height of a building is measured at the center line of its principal front, from the sidewalk grade (or, if setting back from the sidewalk, from the grade of the ground

adjoining the building) to the highest part of the roof, if a flat roof, or to a point 2/3 of the height of the roof, if a gabled or hipped roof. If the grade of the lot or adjoining sidewalk in the rear or alongside of the building falls below the grade at the front, the height shall be measured at the center of the lowest side.

**Ind 51.13 Basement; first floor; number of stories.** A basement is a story whose floorline is below grade at any entrance or exit and whose ceiling is not more than 5 feet above grade at any such entrance or exit. The first floor is the floor next above the basement, or the lowest floor if there is no basement. The number of stories of a building includes all stories except the basement.

**Ind 51.14 Street; alley; court.** (1) A street is any public thoroughfare 30 feet or more in width.

(2) An alley is any public thoroughfare less than 30 feet, but not less than 10 feet, in width.

(3) A court is an open, unoccupied space other than a street or alley and bounded on one or more sides by the walls of a building.

**Ind 51.15 Standard exit.** (1) Every door which serves as a required exit from a public passageway, stairway or building shall be a standard exit door unless exempted by the occupancy requirements of this code.

*Note:* For required exits see Wis. Adm. Code sections Ind 54.06, 55.10, 56.08, 57.09.

(2) Every standard exit door shall swing outward or toward the natural means of egress (except as below). It shall be level with the floor, and shall be so hung that, when open, it will not block any part of the required width of any other doorway, passageway, stairway or fire escape. No revolving door, and no sliding door except where it opens onto a stairway enclosure or serves as a horizontal exit, shall be considered as a standard exit door.

(3) A standard exit door shall have such fastenings or hardware that it can be opened from the inside without using a key, by pushing against a single bar or plate, or turning a single knob or handle; it shall not be locked, barred, or bolted at any time while the building is occupied.

(4) A standard exit doorway shall not be less than 6 feet 4 inches high by 3 feet 4 inches wide, except where especially provided under occupancy classifications and in Wis. Adm. Code section Ind 51.20. Where double doors are provided with or without mullions, the width of each single door may be reduced to 2 feet 6 inches.

(5) All exit doors, unless otherwise exempted by the occupancy requirements of this code, shall be plainly marked by an illuminated translucent exit sign bearing the word EXIT or OUT in plain letters not less than 5 inches in height and in such other places as may be necessary to direct the occupants to the exit doorways.

(6) Doors, windows or other openings which are not exits but which give the appearance of exits shall be effectively guarded.

History: 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 51.16 Stairways.** (1) DEFINITION. By a stairway is meant one or more flights of steps and the necessary platforms connecting them

to form a continuous passage from one level to another within a building or structure, except as provided in subsection (3) (b).

(2) WIDTH. Every required exit stairway, whether enclosed or not, shall be not less than 3 feet 8 inches wide of which not more than 4 inches on each side may be occupied by a handrail. Every platform shall be at least as wide as the stairway, measuring at right angles to the direction of travel. Every straight run platform shall measure at least 3 feet in the direction of travel. Wherever a door opens onto a stairway, a platform shall be provided extending at least the full width of the door in the direction of travel. *Exception:*

(a) In apartment buildings not more than 2 stories in height and having not more than 2 apartments on a floor and in rooming houses, hospitals, hotels and similar buildings not more than 2 stories in height and having not more than 6 living or sleeping rooms on a floor, such stairways shall not be less than 3 feet wide.

(b) If other stairways are provided in addition to those required by this code, such additional stairways need not conform to the width requirements of this code.

(3) HANDRAILS. All stairways and steps of more than 3 risers shall have at least one handrail. Stairways and steps 5 feet or more in width, or open on both sides, shall have a handrail on each side. Stairways and steps which are less than 5 feet in width shall have a handrail on the left hand side as one mounts the stairs and on the open side, if any.

(a) Stairways which are more than 8 feet wide shall be divided by center rails into widths not more than 8 feet nor less than 3 feet 8 inches. Rails shall be not less than 2 feet 6 inches above the nose of the treads or 3 feet 6 inches above the platform except as specified in Wis. Adm. Code section Ind 51.20. Railings on the open sides of stairways and platforms shall be provided with an intermediate member at midheight or with vertical members having a maximum spacing of 11 inches, or its equivalent in safety.

(b) Stairways on the outside of buildings and an integral part thereof, having more than 3 risers, shall have a handrail at each side, and if the stairway is more than 50 feet wide, one or more intermediate handrails shall be provided.

(c) Where an exit door leads to an outside stairway, platform or sidewalk, the level of the platform or sidewalk shall not be more than 7¾ inches below the door sill except as provided in section Ind 51.20 (4) (g).

(4) RISERS AND TREADS. All stairways and steps required as exits by this code shall have a uniform rise of not more than 7¾ inches and a uniform tread of not less than 9½ inches, measuring from tread to tread, and from riser to riser. No winders shall be used. There shall not be more than 18, nor less than 3 risers between platforms or between floor and platform and not more than 22 risers from floor to floor with no platform.

(a) Stairways and steps not required as exits by this code shall have a uniform rise of not more than 8 inches and a uniform tread of not less than 9 inches. If winders are used, the tread shall be at least 7 inches wide at a point one foot from the narrow end.

(b) For stairways to elevated walks, platforms and runways in places of employment see section Ind 1.17 of the general orders on safety issued by the industrial commission.

(c) The edges of all treads and the edges of all stairway landings shall be finished with a non-slippery surface not less than 3 inches in width.

History: 1-2-56; am. (2); (2) (a); (2) (b); Register, June, 1956, No. 6, eff. 7-1-56; r. and recr. Register, September, 1959, No. 45, eff. 10-1-59

**Ind 51.17 Smokeproof stair tower.** (1) A smokeproof stair tower shall be an enclosed stairway which is entirely cut off from the building and which is reached by means of open balconies or platforms. The stairways, landings, platforms and balconies shall be of incombustible material throughout. The enclosing walls shall be of not less than 4-hour fire-resistive construction as specified in Wis. Adm. Code section Ind 51.05, and the floors and ceilings of not less than 2-hour fire-resistive construction as specified in Wis. Adm. Code section Ind 51.06.

(2) The doors leading from the buildings to the balconies and from the balconies to the stairways shall be fire-resistive doors as specified in Wis. Adm. Code section Ind 51.09, and all openings within 10 feet of any balcony shall be protected with fire-resistive windows as specified in Wis. Adm. Code section Ind 51.10, or fire-resistive doors.

(3) Each balcony shall be open on at least one side, with a railing not less than 3'6" high on all open sides.

History: 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 51.18 Interior enclosed stairway.** (1) An interior enclosed stairway shall be completely enclosed with walls of not less than 2-hour fire-resistive construction as specified in Wis. Adm. Code section Ind 51.05, except that in ordinary or frame buildings and in mill or fire-resistive buildings not more than 3 stories in height one-hour fire-resistive enclosures may be used. All doors opening into such enclosures shall be as specified in Wis. Adm. Code section Ind 51.09.

(2) The enclosure shall include at each floor level a portion of such floor which will be at least as wide as the stairway; and such enclosure shall also include the passageway of the first floor level (if any) leading from the stairway to an outside door, so as to afford uninterrupted passage from the uppermost floor to such outside door without leaving the enclosure.

(3) If windows are placed in any such enclosure they shall be fixed fire-resistive windows as specified in Wis. Adm. Code section Ind 51.10, except in outside walls.

**Ind 51.19 Horizontal exit.** (1) A horizontal exit shall consist of one or more openings through or around an exterior wall or occupancy separation, or of one or more bridges or balconies connecting 2 buildings or parts of buildings entirely separated by occupancy separations as described in Wis. Adm. Code section Ind 51.08.

(2) Openings used in connection with horizontal exits shall be protected by fire-resistive doors as specified in Wis. Adm. Code section Ind 51.09. If swinging doors are installed in pairs, they shall be arranged to swing in opposite directions; with direction of travel indicated by signs, except that where the travel is in one direction only,

both doors shall swing in that direction. Such doors shall be kept continuously unlocked whenever the building is occupied and be normally closed or be self-closing and equipped with fusible links.

(3) Floors in horizontal exits shall have a slope of not more than one foot in 6.

(4) All doors and windows within 10 feet of any balcony or bridge shall be fire-resistive doors as specified in Wis. Adm. Code section Ind 51.09, or fire-resistive windows as specified in Wis. Adm. Code section Ind 51.10, except that if such doors or windows are in the same plane, this requirement shall apply only to those within 5 feet of the balcony or bridge.

(5) The floor on each side of a horizontal exit and all passageways leading thereto shall be kept clear and unobstructed at all times.

**Ind 51.20 Fire escapes.** (1) LOCATION. Every fire escape shall be so located as to lead directly to a street, alley, or open court connected with a street.

(a) Every fire escape shall be placed against a blank wall if possible. If such a location is not possible then every wall opening which is less than 6 feet distant horizontally from any tread or platform of the fire escape shall be protected by a fire-resistive door as specified in Wis. Adm. Code section Ind 51.09 or by a fire-resistive window as specified in Wis. Adm. Code section Ind 51.10.

(2) EXITS TO FIRE ESCAPES. Every fire escape shall be accessible from a public passageway or shall be directly accessible from each occupied room. Exits to fire escapes shall be standard exit doors as specified in Wis. Adm. Code section Ind 51.15, except that doors to "A" fire escapes may be not less than 2 feet 6 inches wide.

(3) DESIGN AND FABRICATION. Each part of every fire escape (except counterweights for balanced stairways) shall be designed and constructed to carry a live load of 100 pounds per square foot of horizontal area over the entire fire escape. Each part of every fire escape shall be designed and constructed in accordance with the requirements of Wis. Adm. Code section Ind 53.24, except that the unit stresses therein specified shall be reduced by one-fourth. The minimum sections and sizes specified below shall be increased whenever necessary so that under full load the allowable unit stresses will not be exceeded.

(a) No other material than wrought iron, soft steel or medium steel shall be used for any part of a fire escape, except for weights, separators and ornaments. No bar material less than ¼ inch thick shall be used in the construction of any fire escape, except for separators, ornaments, structural shapes over 3 inches and rigidly built up treads and platforms of approved design. In the fabrication of a fire escape, all connections or joints shall be made by riveting, bolting or welding in an approved manner. All bolts or rivets, except for ornamental work, shall be not less than ⅜ inch in diameter.

(4) PLATFORMS. Each platform on an "A" fire escape shall be at least 28 inches wide; each platform on a "B" fire escape shall be at least 3 feet 4 inches wide. Such widths shall be the clear distance between stringers, measuring at the narrowest point. Each platform shall extend at least 4 inches beyond the jambs of exit opening. The

above minimum widths and lengths shall be increased, wherever necessary, so that no exit door or window will, when open, block any part of the required width of the fire escape. Every platform shall consist of either,

(a) Flat bars on edge, not less than 1 x ¼ inch, but not less than 1¼ x ¼ inch where bolts and separators are used except that platforms and treads constructed of flat bars on edge may be made of material ⅜ inch in thickness provided the material is galvanized after fabrication. Bars shall not be spaced more than 1¼ inches, center to center.

(b) ½ inch or ⅝ inch square bars with sharp edge up, not more than 1½ inches, center to center.

(c) ⅝ inch round bars, not more than 1½ inches, center to center.

(d) Platform and treads may be solid if covered by a roof.

(e) The platform frame shall consist of not less than 2 x ¾ inch flat bars on edge or equivalent, provided the brackets are not more than 4 feet apart. If brackets are more than 4 feet apart, the frame shall be correspondingly stronger and stiffer. Every platform wider than 30 inches, if made of square or round bars, shall have a third frame bar through the center; if made of flat bars, the platform shall have separators and bolts through the center. Frame bars shall not project more than ¼ inch above platform bars, except around the outside of platform.

(f) There shall be a platform at each story above the first, and intermediate platforms if floors are more than 18 feet apart vertically.

(g) Platforms shall not be more than 8 inches below the door sill.

(5) BRACKETS. Brackets for a 28 inch or 30 inch platform, when spaced not more than 4 feet apart, shall be made of not less than ⅞ inch square bars or 1½ x 1½ x ¼ inch angles; such bars or angles shall be larger if the platform is wider or if the brackets are farther apart. Each bracket shall be fastened at the top to the wall by a through bolt (at least ⅞ inch diameter), nut, and washer (at least 4 inch diameter). The slope of the lower bracket bar shall be not less than 30 degrees with the horizontal. The lower bar shall have a washer or shoulder to give sufficient bearing against the wall.

(a) The strength of the wall to which brackets are to be attached shall be carefully considered in determining the spacing, shape and inside connection of brackets, so that under full load the wall will not be unduly strained. Where it is necessary to install brackets adjacent to wall openings they shall be located at a suitable distance therefrom, or the wall shall be properly reinforced.

(6) STAIRWAYS. (a) Each stairway of an "A" fire escape shall be at least 24 inches wide between stringers; such stairway shall have a uniform rise of not more than 8 inches and a uniform run of not less than 8 inches.

(b) Each stairway of a "B" fire escape shall be at least 3 feet 4 inches wide between stringers; such stairway shall have a uniform rise of not more than 8 inches, and a uniform run of not less than 9 inches.

1. The rise is the vertical distance from the extreme edge of any step to the corresponding extreme edge of the next step. The run is the horizontal distance between the same points.

(c) Stairway stringers shall consist of either

1. A 5 inch channel or larger.
2. Two angles 2 x 2 x ¼ inch or larger.
3. Two flat bars 2 x ⅜ inch or larger.
4. One flat bar 6 x ¼ inch or larger.

5. If 2 angles or 2 flat bars are used, they shall be properly tied together by lattice bars, vertical as well as horizontal. If flat bars are used, every stairway of more than 10 risers shall have lateral bracing. The connection of stringers to platform, at top and bottom, shall be at least equal in strength to the stringers and shall safely carry the full live and dead loads. If stringers are carried by intermediate brackets, the stringers shall have a horizontal bearing on the brackets and shall be properly and securely connected thereto.

6. Treads shall consist of either flat or square bars, (not round), of the size and spacing specified for platforms. An "A" tread shall consist of at least 6 square bars, or 7 flat bars. A "B" tread shall consist of at least 7 square bars, or 8 flat bars. A "B" tread made of flat bars shall have separators and bolt through the center. A "B" tread made of square bars shall be trussed.

7. Treads and platforms may be solid if covered by a roof.

(7) BALANCED STAIRWAY. All "B" fire escapes, and all fire escapes on schools, theaters, assembly halls, and hospitals either shall reach to the ground or shall have a balanced stairway reaching to the ground. "A" fire escapes which are not on schools, theaters, assembly halls, or hospitals may terminate in a platform at least 3 feet long, located not more than 10 feet above the ground.

(a) Every balanced stairway shall conform to the requirements for other stairways except that the stringers and top rail may be lighter if they are properly trussed. The counterbalancing device shall be attached to both sides of the stairway equally, or a special attachment shall be used to prevent warping or twisting. The counterbalancing device shall operate gradually and easily as the live load is applied. Cable counterweights are not permitted.

(b) Treads for "A" balanced stairways may be made as follows: two 1¼ x 1¼ x ¼ inch angles at front and back; two 1¼ x ¼ inch bars between, lying flatwise; one inch space between bars. Treads for "B" balanced stairways may be made as follows: two 1½ x 1½ x ¼ inch angles at front and back; two 1½ x ¼ inch bars between, lying flatwise; one inch space between bars. All such treads shall be strongly fastened together with cross bars not more than 14 inches apart.

(8) RAILINGS. A railing at least 42 inches in height and having 2 intermediate rails, uniformly spaced, measuring vertically from the floor of the platform, shall be provided on all open sides of platforms. Railings at least 36 inches in height, measuring vertically from the nose of the treads, shall be provided on the open sides of all stairways and on both sides of balanced stairways. Either a railing or a handrail fastened to the wall shall be provided on each side of all "B" fire escape stairways.

(a) Every railing shall have posts, not more than 5 feet apart made of not less than 1½ x 1½ x ¼ inch angles or tees, or 1¼ inch pipe; top rail not less than 1¼ x 1¼ x ¼ inch angle or equivalent;



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center rail not less than 1¼ x ⅝ flat bar or equivalent. All connections shall be such as to make the railing stiff; 2 bolts (⅜ inch or larger) shall be used at the foot of each post wherever possible, or at least one ½ inch bolt shall be used. Railing shall be continuous. No projections on the inside of the railing shall be permitted. Where a railing returns to the wall, it shall be fastened thereto with a through bolt (at least ⅝ inch diameter), nut, and washer; or (in reinforced concrete) with an approved insert; or the railing shall be made equally secure with a diagonal brace extending at least 3 feet horizontally and 3 feet vertically.

(b) All outside railings which are more than 60 feet above grade shall be at least 6 feet high, measuring vertically from floor of platform or from nose of step. Such railings shall be of special design approved by the industrial commission, having not less than 4 longitudinal rails, and vertical lattice bars not more than 8 inches apart, and proper stiffening braces or brackets.

(9) LADDER TO ROOF. Every fire escape which extends higher than the second floor shall be provided with a ladder leading from the upper platform to the roof, unless the fire escape stairway leads to the roof. The ladder shall have stringers not less than 1¼ inch pipe, or not less than 2 x ⅜ inch flat bars, at least 17 inches apart in the clear. The rungs shall be not less than ½ inch square or ⅝ inch round bars, 14 inches center to center. The stringers shall be securely tied together at intervals no greater than every fifth rung. The stringers of each ladder shall extend not less than 4 feet above the roof coping and return to within 2 feet of the roof, with the top rung of the ladder level with the coping.

(10) OTHER TYPES OF FIRE ESCAPES. Sliding or chute fire escapes may be used, upon the approval of the industrial commission, in place of "A" or "B" fire escapes. Every sliding fire escape shall be provided with a ladder constructed as in Wis. Adm. Code section Ind 51.20 (9), extending from 5 feet above grade, to 4 feet above the roof coping.

History: 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 51.21 Standpipes.** (1) CLASSES OF SERVICE. Standpipe systems are designed for 2 classes of service: (a) for use by fire departments or others trained in handling heavy streams from 2½ inch hose, and (b) for use by occupants of a building on incipient fires. These are referred to in these sections as fire departments, and first aid standpipes, respectively. The features of each system may be combined in a single equipment, if served by an automatic water supply conforming to Wis. Adm. Code section Ind 51.21 (2) (g) or (h). All threads on hose and hose connections shall be interchangeable with those of the public fire department.

(2) FIRE DEPARTMENT STANDPIPES. (a) Standpipes shall be provided for all buildings exceeding 60 feet in height. Required standpipes shall be installed as construction progresses, to make them available to the fire department in the topmost floor constructed.

(b) Standpipes shall be sufficient in number so that any part of every floor area can be reached within 30 feet by a nozzle attached to 100 feet of hose connected to the standpipe. When 2 or more standpipes are required, they shall be cross connected at the bottom, and

equipped with individual controlling valves located not higher than the first story.

(c) Standpipes shall be protected against mechanical and fire damage, with outlets in stairway enclosures; where stairways are not enclosed, outlets shall be at inside or outside of outside walls, within one foot of a fire tower, interior stairway or fire escape. Dry standpipes shall be accessible for inspection and not concealed.

(d) No required standpipe shall be less than 4 inches in diameter, and not less than 6 inches in diameter for buildings exceeding 75 feet in height. Material shall be steel or wrought iron pipe with approved fittings, designed for a working pressure of 100 pounds in excess of the static pressure due to elevation. An approved 2½ inch hose valve shall be located at each story, not over 5 feet above the floor level. An approved pressure reducing device shall be installed at hose valves where the pressure would otherwise be in excess of 50 pounds. Where a standpipe is not normally under pressure, hose valves shall be equipped with a tight fitting cap on a chain and having lugs for a spanner wrench.

(e) An approved siamese connection with a check valve in each inlet shall be installed on a 4 inch pipe connecting with each standpipe system and shall be marked "To Standpipe". The elevation of the connection shall be not over 3 feet above the sidewalk or ground. An automatic drip valve shall be installed where necessary to prevent freezing. In buildings with several standpipes, more than one siamese connection may be required.

(f) Fire department standpipes need not be equipped with attached hose.

(g) Automatic water supplies will not ordinarily be required, except as provided in Wis. Adm. Code section Ind 51.21 (2) (h), or where judged necessary by reason of the high combustibility or potential hazard of the occupancy. When required, they shall be designed to provide not less than 40 pounds flowing pressure at the top outlet, with volume for two fire streams. Any of the following supplies will be acceptable:

1. Connection to city water works system when providing required minimum volume and pressure.

2. Gravity tank of not less than 3,500 gallons capacity, elevated 50 feet above the top story.

3. Pressure tank of 5,250 gallons gross capacity (3,500 gallons water capacity).

4. Automatic pump or pumps, with combined effective capacity of 500 gallons per minute.

(h) An automatic water supply from an approved fire pump shall be provided in buildings over 150 feet high, or in buildings over 10,000 square feet in area per floor and requiring a standpipe. The capacity of the pump shall be not less than 500 gallons per minute for a 4 inch standpipe, 750 gallons per minute for 2 interconnected 4 inch or single 6 inch standpipes, and 1,000 gallons per minute for larger systems.

(3) FIRST AID STANDPIPES. (a) Standpipes shall be provided as required in Wis. Adm. Code sections Ind 54.14, Ind 55.33, and Ind 57.21.



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# Chapter Ind 52

## GENERAL REQUIREMENTS


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**Ind 52.001 Design and supervision.** (1) Every new building containing more than 50,000 cubic feet total volume, or addition to a building which by reason of such addition results in a building containing over 50,000 cubic feet total volume, or structural alteration to a building containing over 50,000 cubic feet total volume shall be designed by an architect or engineer in accordance with the provisions of this code; and shall be constructed under the supervision of an architect or engineer who shall be responsible for its erection in accordance with the plans and specifications of the designer. No change from the original plans and specifications shall be made except with the knowledge and consent of the designer, and as provided in Wis. Adm. Code section Ind 50.10.

(2) On completion of the construction, the supervising architect or engineer shall file a written statement with the industrial commission certifying that, to the best of his knowledge and belief, the construction has been performed in accordance with the plans and specifications approved by the commission.

(3) No owner shall construct or alter any building, or portion of a building, or permit any building to be constructed or altered, except in accordance with the provisions of this section.

*Note:* By the term "architect" or "engineer" above is meant "registered architect" or "registered professional engineer", as defined in the Architects and Professional Engineers Registration Act, Section 101.31, Wis. Stats.

**History:** 1-2-56; cr. (2) Register, August, 1957, No. 20, eff. 9-1-57.

**Ind 52.01 Height and class of construction.** (1) All buildings higher than 75 feet above the adjacent grade shall be of fire-resistive construction.

(2) Buildings of mill construction shall not exceed a height of 75 feet in which height there shall not be more than 7 stories; provided,

that the height of a building erected on sloping ground may be not to exceed 75 feet plus a vertical distance equal to the vertical change in slope along the length of any side of such building, but in no case shall such height exceed 85 feet above the adjacent finished ground level. Towers, other than tanks, spires and steeples erected as a part of the building and not used for habitation or storage may extend not to exceed 20 feet above such height limit.

(3) Buildings of ordinary construction shall not exceed a height of 50 feet in which height there shall be not more than 4 stories; provided, that the height of a building erected on sloping ground may be 50 feet plus a vertical distance equal to the vertical change in slope along and in the length of any side of such building, but in no case shall such height exceed 60 feet above the adjacent finished ground level. Towers, other than tanks, spires and steeples not exceeding 20% of the roof area, erected as a part of such building and not used for habitation or storage may extend not to exceed 15 feet above such height limit.

(4) Buildings of frame construction shall not exceed a height of 35 feet in which height there shall be not more than 2 stories, except as provided in Wis. Adm. Code section Ind 57.01; provided, that the height of a building erected on sloping ground may be 35 feet plus a vertical distance equal to the vertical change in slope along the length of any side of such building, but in no case shall such height exceed 40 feet above the adjacent finished ground level. Spires, towers, other than tanks, or steeples not exceeding 20% of the roof area, erected as a part of such building and not used for habitation or storage may extend not to exceed 20 feet above such height limit.

(5) In every building more than 4 stories in height, all doors, windows and other openings in outside walls shall be protected with fire-resistive doors or shutters as specified in Wis. Adm. Code section Ind 51.09 or fire-resistive windows as specified in Wis. Adm. Code section Ind 51.10, unless such openings are on streets or on alleys or outer courts 20 feet or more in width.

Ind 52.02 Windows. (1) Every room in which one or more persons live, sleep, or are employed, (except storage rooms or other rooms where the nature of the occupancy will not permit) shall be lighted by a window or windows opening directly upon a street or alley, or upon a court (as defined in Wis. Adm. Code section Ind 52.04) on the same lot with the building. The windows shall be so constructed and distributed as to afford proper light and ventilation. Every building more than 40 feet deep (measuring at right angles to the windows) shall have windows on at least 2 sides. *Exception*:

(a) The provisions of this rule may be waived for factory, office or mercantile buildings if provisions are made for proper artificial lighting, and if ventilation is provided in accordance with the provisions of the heating, ventilating and air conditioning code.

(b) Every building more than one story in height which does not have windows opening directly upon a street in each story above the first, shall be provided with a suitable access for fire department use. Such access shall be a window or door opening through the wall on each floor above the first story. The opening shall be at least 36 inches in width and not less than 48 inches in height with the sill not more than 32 inches above the floor. The openings shall be so spaced that

there will be one opening in each 100 feet of wall length in any accessible wall of the building. This requirement for access openings for fire department use shall not apply where a building is equipped throughout with an automatic sprinkler system approved for fire protection purposes.

History: 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 52.03 Window cleaning.** (1) Where the tops of windows to be cleaned are more than 20 feet above the floor, ground, flat roof, balcony, or permanent platform, one of the following means shall be provided to protect the window cleaners.

(a) Approved attachments for window cleaner safety belts to which belts may be fastened at each end. Said attachments shall be permanent devices that shall be firmly attached to the window frame, or to the building proper, and so designed that a standard safety belt may be attached thereto; or

(b) An approved portable platform that is projected through the window or supported from the ground, floor, roof or platform level, for the window cleaner to stand upon and that is designed, constructed, maintained and equipped with handrail and toeboard in compliance with the requirements of chapter Ind 1, rules on Safety.

(c) A suspended scaffold, swinging scaffold, swinging chair scaffold, or boatswain's chair scaffold designed, constructed, equipped and maintained in compliance with the requirements of Wis. Adm. Code chapter Ind 35, rules on Safety in Construction, or

(d) Other equally effective devices.

(e) Where the window consists of a fixed panel not more than 24 inches in width alongside a removable panel, the fixed panel may be cleaned by reaching through the opening of the removable panel. Where the window consists of a fixed panel between 2 removable panels, the fixed panel may be cleaned by reaching through the openings if such fixed panel is not more than 36 inches in width.

(2) For cleaning the insides of skylights (the highest parts of which are more than 20 feet above the floor, ground, balcony or permanent platform), to which access cannot be gained by any of the means described in Wis. Adm. Code subsection Ind 1.16 (1), scaffolds as specified in chapter Ind 35, rules on Safety in Construction, shall be provided.

(3) All equipment, including building parts and attachments, used in connection with window cleaning, shall be maintained in reasonably safe condition while in use and shall be inspected at least once each month while in use, and within 30 days before their use. It shall be the responsibility of the owner of the individual safety devices or equipment to inspect and maintain the devices or equipment belonging to him so that each will comply with the requirements of this section.

(4) Where the attachments specified in subsection (1) (a) are relied upon for compliance with the provisions of this rule, said employer shall furnish or see that there is provided, an approved suitable safety belt for each employe while cleaning windows.

*Note:* It will be the policy of the industrial commission to accept anchors and safety belts which have been tested and approved by the Underwriters' Laboratories.

History: 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 52.04 Definitions of courts.** (1) By inner court is meant an open air shaft or court surrounded on all sides by walls.

(2) By inner lot line court is meant a court bounded on one side and both ends by walls and on the remaining side by a lot line.

(3) By outer court is meant a court bounded on 3 sides with walls and on the remaining side by a street, alley or other open space not less than 15 feet wide.

(4) By outer lot line court is meant a court with one side on a lot line and opening to a street or open space not less than 15 feet wide.

**Ind 52.05 Size of courts.** (1) In applying the following requirements, a building from 30 to 43 feet high shall be considered as having at least 3 stories, and each additional 13 feet shall be considered an additional story.

(2) Outer lot line courts shall be not less than 3 feet wide for a court 2 stories or less in height and 40 feet or less in length, measured from the lot line to the wall of the building. For each additional story in height, the width of such court shall be increased one foot; and for each additional 15 feet or fraction thereof in length, the width of such court shall be further increased one foot.

(3) Outer courts between wings or parts of the same building, or between different buildings on the same lot, shall be not less than 6 feet wide for a court 2 stories or less in height and 40 feet or less in length. For each additional story in height, the width of such court shall be increased one foot, and for each additional 10 feet or fraction thereof in length, the width of such court shall be further increased one foot.

(4) Where outer courts or outer lot line courts open at each end to a street or other open space not less than 15 feet wide, the above lengths may be doubled.

(5) Inner lot line courts one story high shall be not less than 4 feet wide and not less than 40 square feet in area. Inner lot line courts two stories high shall be not less than 6 feet wide and not less than 60 square feet in area. For every additional story every such inner lot line court shall be increased by at least one lineal foot in length and one lineal foot in its width.

(6) Inner courts shall be not less than 10 feet in width nor less than 150 square feet in area for courts two stories or less in height; and for every additional story every such inner court shall be increased by at least one lineal foot in its length and one lineal foot in its width.

(7) Courts shall not be covered by a roof or skylight but the entire required area shall be open and unobstructed from the bottom thereof to the sky. No fire escape or stairway shall be constructed in any court unless the court be enlarged proportionately.

(8) Walls of inner courts whose least horizontal dimension is less than one-fourth the height, shall be faced with material with a permanent white surface or shall be painted white at least every 2 years.

(9) No buildings shall be altered or enlarged to encroach upon space reserved under this code for light and air on the lots or parcels of ground on which such building is erected.

**Ind 52.06 Ventilation of courts.** At the bottom of every shaft or inner court there shall be sufficient access to such shaft or court to enable it to be properly cleaned out. Every inner court which is re-

quired under Wis. Adm. Code section Ind 52.02 and which is more than one story in height shall have an intake for fresh air, leading from the street or other open space. The area of such intake in square feet shall equal at least .002 of the number of cubic feet contained in said court, but such area need not be more than 50 square feet. Every intake shall be of not less than 2-hour fire-resistive construction and unless said intake is used as a passageway for persons, there shall be no openings into the same other than the inlet and outlet.

**Ind 52.10 Chimneys.** (1) The walls of all chimneys shall be built of brick or other approved fire-resistive material, except that a metal smokestack may be provided as specified in Wis. Adm. Code section Ind 52.11. No chimney shall rest upon a flooring of wood nor shall any wood be built into, or in contact with any chimney. Headers, beams, joists and studs shall not be less than 2 inches from the outside face of a chimney. The foundation of every chimney, flue, or stack, shall be designed and built in conformity with the requirements for foundations for buildings. In no case shall a chimney be corbeled out more than 8 inches from the wall and in every case the corbeling shall consist of at least 5 courses of brick. Chimneys shall extend at least 3 feet above flat roofs and not less than 2 feet above the ridge of gable and hip roofs, and lime-cement or cement mortar shall be used in the laying of chimney masonry above the roof line.

(2) Every masonry chimney shall have walls at least 8 inches in solid thickness, except that in a chimney with a flue not larger than 260 square inches where a fire clay or other suitable refractory clay flue lining is used for the full height of the chimney the walls shall not be less than 4 inches in solid thickness. No smoke flue shall have a cross sectional area less than 64 square inches, except that flue linings 7 inches by 7 inches inside, or 8 inches in diameter inside, may be used.

(3) All flue linings shall be adapted to withstand reasonably high temperatures and flue gases and shall have a softening point not lower than 1800° F. Flue linings shall be not less than ⅝ inch in thickness and shall be built in as outer walls of the chimney are constructed. Flue linings shall start from a point not less than 8 inches below the bottom of the smokepipe intake and shall be continuous to a point not less than 4 inches above the enclosing walls.

(4) Where there is more than one smokepipe connected to a flue, the connections shall be at different levels. Two or more heating units or appliances may be connected to a common smokepipe or breeching if joined by Y fittings as close as practicable to the flue. In all such cases, the size of the breeching and the flue shall be sufficient to accommodate the total volume of flue gases.

(a) *Cleanout opening.* Every chimney shall be provided with a cleanout opening at the base. Such openings shall be equipped with metal doors and frames arranged to remain closed when not in use.

(5) Every chimney shall be designed to withstand the following wind pressure in pounds per square foot over the diametrical area:

| | |
|---|---|
| (a) Square chimneys | 30 |
| (b) Polygonal chimneys | 25 |
| (c) Round chimneys | 20 |

(6) Prefabricated chimneys complying with the requirements of Wis. Adm. Code section Ind 58.67 of the Heating, Ventilating and Air Conditioning Code may be used in lieu of masonry chimneys if approved by the industrial commission and are provided with foundations as specified for masonry chimneys, or metal smokestacks or as otherwise approved.

**History:** 1-2-56; am. (1), r. and recr. (4), Register, August, 1957, No. 20, eff. 9-1-57; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 52.11 Metal smokestacks.** (1) Steel or iron smokestacks may be used in place of masonry chimneys specified in Wis. Adm. Code section Ind 52.10, in which case the thickness of the metal shall be not less than 3/16 inch for heights up to 40 feet and ¼ inch for greater heights. Such stacks when used for manufacturing, for high pressure boilers, furnaces or other similar heating or manufacturing appliances shall be lined with fire brick for a distance of not less than 25 feet from the place where the smoke pipe enters and shall be protected on the outside up to and through the roof of the building with 8 inches of masonry, or a metal shield which provides an 8 inch ventilated air space between such shield and the stack. All stacks shall be properly guyed when the height of the stack exceeds 15 times its least diameter.

*Exception:*

(a) Public utility or industrial power plants are exempted from the protection requirements of this paragraph if they are of fire-resistive construction.

(2) Smokestacks under 30 feet in height may be constructed of not less than No. 10 U. S. Gauge steel, with either welded or riveted joints, and may be mounted directly upon masonry chimneys or foundations or upon industrial heating or power boilers provided all of which are designed to support the stack load. A clearance of not less than 6 inches shall be maintained at all times around such smokestack and any inflammable material within 12 inches of such smokestack shall be protected by ¼ inch of asbestos covered by sheet metal.

**Ind 52.12 Smoke pipes.** (1) No smoke pipe or breeching serving boilers, furnaces or other similar heating appliances shall pass through any floor, outside window or door, nor through any combustible roof or combustible outside wall, nor through any closet, attic or similarly concealed space.

(2) Where necessary to pass through any partition of non-fire-resistive construction, every smoke pipe shall be encased with incombustible material at least 4 inches thick or with a double safety thimble made of two concentric rings of sheet metal with at least one inch open air space between and with the outer ring covered with at least ¼ inch asbestos.

(3) No part of any smoke pipe shall be placed nearer to any non-fire-resistive partition or wall than the diameter of the pipe, nor nearer to any non-fire-resistive ceiling than 1½ times the diameter; but the above distances may be reduced by one-half, if the wall or ceiling is covered with not less than ¼ inch asbestos board covered with sheet metal, or with equivalent protection.

**Ind 52.13 Steam and hot water pipes.** No steam pipe or pipe carrying hot water at a temperature exceeding 180 degrees shall be placed within one inch of any woodwork. Every such steam or hot water

pipe passing through a combustible floor, ceiling or partition, shall be protected by a metal tube one inch larger in diameter than the pipe and shall be provided with a metal cap. All wooden boxes or casings enclosing steam or hot water pipes, or wooden covers to recesses in walls in which steam pipes are placed, shall be lined with metal.

**Ind 52.14 Ducts.** Every vertical shaft housing air ducts or a group of ducts in buildings in the theater, school, or hotel classification, shall be enclosed with incombustible material smoothly finished on the inside and having a fire-resistive rating as required for each specific situation.

**History:** 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 52.15. History:** 1-2-56; r. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 52.16 Floor protection.** (1) All stoves and ranges used for cooking, heating or laundry purposes using solid or liquid fuel, and which are more than 16 square feet in horizontal area or which have a flame at the bottom shall be placed on a fire-resistive floor projecting at least 2 feet on each side. If such floor rests on or is in contact with any combustible material, then the fire-resistive floor layer shall be at least 5 inches thick and shall be hollow, with air spaces running horizontally through the same. The air spaces shall be open at both ends and shall be so placed that air can circulate through them; the horizontal area of the air spaces shall equal at least one-half the horizontal area of the slab.

(2) The air spaces may be secured by using hollow tile placed end to end, or by embedding wrought or sheet iron pipes in a layer of concrete. The air spaces should parallel the short dimension of the slab.

(3) If the stove or range is raised at least 6 inches above the floor and such air space is not enclosed, then the fire-resistant floor layer may be reduced to not less than 2 inch solid thickness, without air spaces, provided it is covered with sheet metal.

(4) All stoves and ranges using solid or liquid fuel and which are not more than 16 square feet in horizontal area and not having a flame at the bottom shall, if placed on a combustible floor, be raised at least 6 inches above the floor, and such air space shall not be enclosed. Such floor shall be protected with a stove board of sheet metal or asbestos, projecting at least one foot on all sides.

(5) Gas ranges, domestic hot water heaters and hot plates shall be supported at least 6 inches above any wood floor or other combustible material and, if less than 12 inches above the floor, the wood shall be protected by a metal shield, or such equipment may rest on a masonry support.

(a) The above dimension of 6 inches may be reduced to 3½ inches if the bottom is suitably protected with a metal shield.

**Ind 52.17 Wall and ceiling protection.** (1) All stoves and ranges used for cooking or laundry purposes and all domestic hot water heaters shall be placed at least 24 inches away from any combustible wall, partition or ceiling, except that such distance may be reduced to 12 inches if the wall, partition or ceiling is protected with at least ¼ inch asbestos board covered with sheet metal, or with an equivalent protection.

(2) The above distances may be reduced one-half in the case of stoves and ranges less than 16 square feet in area, and also in the case of gas ranges of greater area if proper insulation is incorporated in the back of the range.

**Ind 52.18 Gas vents.** All gas ranges, except those for domestic use, hot water heaters, and other gas fired equipment shall be provided with vent pipes conforming to the requirements for smoke pipes as specified in Wis. Adm. Code section Ind 52.12.

**Ind 52.19 Gas and oil lamps; gas service.** (1) Gas and oil lamps shall not be used where electricity is available, except in private apartments.

(2) Gas and oil lamps shall be placed at least 6 feet above the floor level, at least 6 inches from any combustible partition or wall, and at least 2 feet (measured from top of flame) below any combustible ceiling unless properly protected by a metal shield with at least 2 inches of air space above. Swinging brackets shall be provided with a guard or stop so that the light cannot come nearer to the partition or wall than one foot. In aisles and public passageways, every such light shall be protected by an incombustible guard unless the light is at least 7 feet above the floor. Gas and oil lights shall be kept at least 2 feet from any drape or window curtain.

(3) Every gas supply main shall have a service cock outside of the building, so placed and maintained that it can be shut off at any time without entering the building.

**Ind 52.20 Electrical work.** All electrical work shall conform to the requirements of the Wisconsin state electrical code of the industrial commission.

*Note:* For the design requirements for transformer vaults, see chapter E 450 of the Wisconsin state electrical code.

**History:** 1-2-56; am. Register, January, 1961, No. 61, eff. 2-1-61.

**Ind 52.21 Location and maintenance of exits.** Every exit mentioned in Wis. Adm. Code sections Ind 51.14 to Ind 51.19, inclusive, shall lead to a street, alley or open court connected with a street. All such exits and all passageways leading to and from the same, shall be kept in good repair and unobstructed at all times.

**Ind 52.22 Television and radio receiving antenna.** (1) The requirements of this section shall apply to the outdoor portion of all apparatus, more than 12 feet in height, used for receiving television or radio waves.

(2) All television and radio antenna systems, including the supporting tower or mast, shall be constructed of galvanized steel or other corrosive-resistant incombustible material. Where approved by the industrial commission, towers constructed of wood or wood poles set in the ground may be used to support antenna systems but no wood tower or wood pole may be mounted on the roof of any building or structure.

(3) The antenna and tower shall be designed to support the dead load of the structure plus an ice load at least ½ inch in radial thickness. The ice load shall be computed only upon the wires, cables, messengers and antenna.

(a) The tower or mast shall be braced or guyed and anchored to resist a horizontal wind pressure of not less than 30 pounds for every square foot (net area) of exposed surface. Guy wires shall not be anchored to a chimney or to any roof ventilator or vent pipe.

(4) Antenna systems installed on the roof of a building shall not be supported by or attached to a chimney. All such installations shall be mounted on an independent platform or base and anchored in place. The platform or base of the tower shall be large enough to distribute the weight of the structure over sufficient roof area so the roof construction will safely support the weight of the structure in addition to the required live and dead roof loads.

(5) All antenna systems shall be so installed that no part of the structure will be nearer to a street, or other public thoroughfare, than the height of the antenna as measured from its platform or base to the topmost point. No wires, cables, or guy wires shall extend over any street or other public thoroughfare or over any electric power or communication lines.

(6) Poles used for electric power or for communication lines shall not be used for supporting or for guying any antenna system. Where antenna installations are so located that damage will be caused to adjacent power or communication lines by the falling of the antenna structure, a separate safety wire shall be attached to top of the tower and secured in a direction away from the power or communication line.

(7) Electrical installations in connection with antenna systems, including the grounding of the tower or mast, shall comply in all respects with the requirements of the Wisconsin state electrical code.

## GENERAL SANITATION REQUIREMENTS

**Ind 52.50 Toilet rooms required.** (1) Every place of employment and public building shall have adequate toilet rooms as provided in the occupancy classifications of this code, completely enclosed and so arranged as to insure privacy.

(2) Separate toilet rooms shall be provided for employes and the general public where deemed necessary by the industrial commission or by the state board of health.

History: 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 52.51 Toilet rooms for the two sexes.** (1) Where the 2 sexes are accommodated, separate toilet rooms shall be provided except

(a) In apartment houses;

(b) If approved in writing by the industrial commission or the state board of health, or their authorized agents, in buildings accommodating not more than 5 persons of both sexes, provided the door of such toilet room is kept locked and the key is kept in a place accessible to all such persons. But whenever the number of such persons shall exceed 5, separate toilet rooms shall be provided.

(2) Entrances to toilet rooms for the 2 sexes shall be properly separated, by screens or otherwise, and shall, wherever possible, be at least 20 feet apart; except this requirement does not apply where the entrance doors to toilet rooms used by the 2 sexes are located in an exterior wall of the building.

**Ind 52.52 Sex designated.** Wherever women are employed or accommodated, each toilet room shall be distinctly marked with regard to the sex which uses it, and no person shall be allowed to use a toilet room assigned to the other sex, except as provided in Wis. Adm. Code section Ind 52.51. The door or room labels shall be the words MEN, or WOMEN, respectively, in letters not less than one inch in height.

**Ind 52.53 Location, light and ventilation.** (1) Every toilet or bathroom shall be so located as to open to outside light and air, by windows or skylights opening directly upon a street, alley or court, except as provided in Wis. Adm. Code section Ind 52.54.

(2) The glass area for a toilet room containing one closet or urinal shall be at least 4 square feet, with 2 square feet additional for each additional closet or urinal.

(3) No toilet room shall have a movable window or ventilator opening on any elevator shaft, or on any court which contains windows of sleeping rooms above.

(4) Every toilet room having more than one fixture (closets and urinals) shall be ventilated in accordance with the provisions of Wis. Adm. Code section Ind 58.48 of the heating, ventilating and air conditioning code issued by the industrial commission, except that this requirement shall not apply to chemical or septic toilets which are installed in accordance with the provisions of the chemical toilet code or the septic toilet code issued by the state board of health.

(a) The size of gravity vent ducts, if surmounted with effective siphon type hoods, may be determined as follows: $\frac{A \times 2}{300}$ = net cross sectional area of vent duct in square feet.

Where A = floor area in the toilet room in square feet.

History: 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 52.54 Location without outside windows; when permitted.** Toilet rooms will be permitted without windows if they are ventilated in accordance with the requirements of Wis. Adm. Code section Ind 58.48 of the heating, ventilating and air conditioning code issued by the industrial commission.

**Ind 52.55 Artificial light.** Every toilet room, except in connection with private rooms or apartments, shall be artificially lighted during the entire period that the building is occupied, wherever and whenever adequate natural light is not available, so that all parts of the room, especially the toilet compartments shall be provided with artificial light intensity of not less than 2.5 foot candles at the floor level.

**Ind 52.56 Size.** Every toilet room shall have at least 14 square feet of floor area with a minimum width of 3 feet, and at least 100 cubic feet of air space for each water-closet and each urinal in addition to the space required for lavatories if installed within the toilet room.

**Ind 52.57 Floor and base.** Every toilet room, except those installed and used only in connection with private apartments, shall have the entire floor and the side walls to a height of not less than 6 inches made waterproof with ceramic tile, terrazzo, painted concrete, marble, slate, monolithic asphalt or other approved material impervious to water.

# Chapter Ind 53

## STRUCTURAL REQUIREMENTS


| | | | |
|---|---|---|---|
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**Ind 53.001 Floor, roof and sidewalk loads.** (1) DEAD LOADS. All buildings and structures, and parts thereof, shall be designed and constructed to support in addition to the minimum superimposed live loads specified in this section, the actual dead weight of all component members; and in addition thereto, an allowance for the weight of partitions, ceiling and floor finish, and concentrated loads such as safes, mechanical apparatus and similar equipment.

(2) LIVE LOADS. All buildings and structures, and parts thereof, shall be designed and constructed to support the following minimum superimposed live loads uniformly distributed in pounds per square foot of horizontal area in addition to the dead load:

(a) *Theaters and assembly halls with fixed seats:*

| | |
|---|---|
| 1. Auditorium | 50 |
| 2. Lobbies, corridors and passageways | 80 |
| 3. Stairways | 80 |

(b) *Assembly halls without fixed seats:*

| | |
|---|---|
| 1. Auditorium | 100 |
| 2. Lobbies, corridors and passageways | 80 |
| 3. Stairways | 80 |

(c) *School, library, museum classification:*

| | |
|---|---|
| 1. Instruction rooms, study rooms, reading rooms, exhibition rooms, art display rooms, laboratories | 50 |
| 2. Vocational rooms | 100 |
| 3. Library book stacks | 100 |
| 4. Lobbies, corridors and passageways | 80 |
| 5. Stairways | 80 |

(d) *Apartment, hotel, place of detention classification:*

| | |
|---|---|
| 1. Living rooms, sleeping rooms | 40 |
| 2. Lobbies, corridors, passageways | 80 |
| 3. Offices and similar areas | 60 |
| 4. Stairways | 80 |
| 5. Dining rooms | 100 |

(e) *Office buildings:*

| | |
|---|---|
| 1. Offices | 50 |
| 2. Commercial | 100 |
| 3. Stairways | 80 |

(f) *Mercantile establishments:*

| | |
|---|---|
| 1. All floor areas and stairways | 100 |

(g) *Factories and workshops:*

| | |
|---|---|
| 1. All floor areas and stairways | 100 |

(h) *Garages:*

1. All floor areas ..... 8000 pound axle load in any possible position or 80 pounds per square foot. (Whichever produces the greater stress.)

(i) *Grandstands, reviewing stands, bleachers:*

| | |
|---|---|
| 1. All areas | 100 |

| | |
|---|---|
| (j) *Stages, in theaters and assembly halls* | 150 |
| (k) *Roofs* | 30 |
| (l) *Sidewalks* | 250 |

(3) The above live load requirements shall be considered only as a minimum. In every case where the loading is greater than this minimum, the design of the building or structure, or part thereof, shall be for the actual load and loading conditions.

(4) The following reductions in assumed live loads shall be permitted in designing girders, columns, piers and walls in fire-resistive buildings.

(a) No reduction of the assumed live load shall be allowed in the design of any slabs, joints or beams.

(b) A reduction of one per cent of the total live load used in the design of girders shall be allowed for each 20 square feet of tributary floor area, with a maximum allowable reduction of 15%. This reduction shall not be carried into the columns nor shall such reduction be used in the design of buildings to be used or occupied as warehouses or for storage purposes.

(c) For determining the total live loads carried by columns, piers and walls, the following reductions shall be permitted, based on the assumed live loads applied to the entire tributary floor area.

1. Warehouses and Storage Buildings

| | |
|---|---|
| a. Carrying the roof | 0% |
| b. Carrying 1 floor and roof | 0% |
| c. Carrying 2 floors and roof | 5% |
| d. Carrying 3 floors and roof | 10% |
| e. Carrying 4 floors and roof | 15% |
| f. Carrying 5 or more floors and roof | 20% |

2. Manufacturing Buildings, Stores and Garages
   a. Carrying the roof ..... 0%
   b. Carrying 1 floor and roof ..... 0%
   c. Carrying 2 floors and roof ..... 10%
   d. Carrying 3 floors and roof ..... 20%
   e. Carrying 4 or more floors and roof ..... 30%
3. All Other Buildings
   a. Carrying the roof ..... 0%
   b. Carrying 1 floor and roof ..... 0%
   c. Carrying 2 floors and roof ..... 10%
   d. Carrying 3 floors and roof ..... 20%
   e. Carrying 4 floors and roof ..... 30%
   f. Carrying 5 floors and roof ..... 40%
   g. Carrying 6 floors and roof ..... 45%
   h. Carrying 7 or more floors and roof ..... 50%

(5) The following reductions in assumed live loads shall be permitted in designing columns, piers and walls in buildings of mill and ordinary construction.

(a) *Warehouses and storage buildings*
   1. Carrying the roof ..... 0%
   2. Carrying 1 floor and roof ..... 0%
   3. Carrying 2 floors and roof ..... 5%
   4. Carrying 3 or more floors and roof ..... 10%

(b) *Manufacturing buildings, stores and garages*
   1. Carrying the roof ..... 0%
   2. Carrying 1 floor and roof ..... 0%
   3. Carrying 2 floors and roof ..... 10%
   4. Carrying 3 or more floors and roof ..... 20%

(c) *All other buildings*
   1. Carrying the roof ..... 0%
   2. Carrying 1 floor and roof ..... 0%
   3. Carrying 2 floors and roof ..... 10%
   4. Carrying 3 floors and roof ..... 20%
   5. Carrying 4 or more floors and roof ..... 30%

**Ind 53.01 Wind pressure.** (1) Every building shall be designed to resist a horizontal wind pressure of not less than 20 pounds for every square foot of exposed surface, in addition to the dead loads and the live loads specified above, except as provided in Wis. Adm. Code subsection Ind 55.68 (4) and section Ind 52.22.

(2) If the overturning moment due to wind pressure exceeds 75% of the moment of stability of the structure due to dead load only, the structure shall be anchored to its foundations, which shall be of sufficient weight to insure the stability of the structure; and sufficient diagonal bracing or rigid connections between uprights and horizontal members shall be provided to resist distortion.

(3) The overturning moment may be disregarded in a structure less than 100 feet in height if the height does not exceed twice the width.

(4) Members subject to stresses produced by a combination of wind and other loads may be proportioned for unit stresses 33⅓% greater than those specified for dead and live load stresses, provided the section thus required is not less than that required for the combination of dead load, live load and impact (if any).

**Ind 53.02 Foundations.** (1) The permissible loads on natural earth shall not be more than the following, in tons per square foot:

(a) Quick sand and alluvial soils ---------- ½
(b) Soft clay ---------- 1
(c) Ordinary clay and sand together in layers, wet and spongy 2
(d) Clay or fine sand, firm and dry ---------- 3
(e) Sand, compact and well cemented ---------- 4
(f) Gravel and coarse sand, well packed ---------- 5
(g) Hard pan or shale ---------- 6
(h) Rock ----------Not more than 20% of the ultimate crushing strength of such rock.

(2) Where material at footing excavation level is such as to permit loads in excess of 2 tons per square foot, and the design is for loading in excess of 2 tons per square foot, 2 inch hand auger test holes shall be bored at intervals not exceeding 30 feet in any direction within the building area to a depth of at least 5 feet below the base of the footings, to determine the character of the underlying material. Allowable loading shall be in accordance with the above table for the material encountered.

(3) The maximum, or safe working load for piles shall be determined by the following formula:

$$L = \frac{2WH}{S+0.1} \text{ for steam hammer}$$

$$L = \frac{2WH}{S+1} \text{ for drop hammer}$$

in which formula

$L$ = safe load in pounds
$W$ = weight of hammer in pounds
$H$ = fall of hammer in feet
$S$ = penetration or sinking of the pile under the last blow, in inches.

(4) In no case shall the maximum load on a timber pile exceed 500 pounds per square inch of the section of the pile at mid-length.

**Ind 53.03** Masonry construction; general requirement. The requirements of Wis. Adm. Code sections Ind 53.03 to Ind 53.13, inclusive, herein shall apply to the construction of all masonry footings, foundations, walls, columns, piers and similar work under this code.

**Ind 53.04** Natural building stone and cast stone. (1) RUBBLE MASONRY. The stresses in rubble stone masonry, due to all dead and live loads, shall not exceed 100 pounds per square inch when laid in lime-cement mortar, or 140 pounds per square inch when laid in Portland cement mortar.

(2) ASHLAR MASONRY. The stresses in ashlar or carefully coursed masonry, due to all dead and live loads shall not exceed the following at any point:

| Kind of Stone | Laid in Lime-Cement Mortar | Laid in Cement Mortar |
|---|---|---|
| | (Pounds per Square Inch) | |
| Granite | 640 | 800 |
| Limestone | 400 | 500 |
| Marble | 400 | 500 |
| Cast Stone | 400 | 500 |
| Sandstone | 320 | 400 |

(3) WEATHER RESISTANCE OF STONE. All natural building stone to be used in masonry exposed to the weather or frost action shall be such that the strength and structure of the stone will not be affected by the weathering or frost action.

*Note:* Where the weather resistance of a stone is questioned this will require freezing and thawing tests as prescribed under the specification of the American Society for Testing Materials.

(4) All cast stone shall be branded with a permanent identification mark of the manufacturer which shall be registered with the industrial commission.

(5) The average compressive strength of cast stone taken on four representative samples at the age of 28 days or when delivered on the job shall be not less than 5000 pounds per square inch with an individual minimum of 4500 pounds per square inch, and the average absorption of such samples shall be not more than 7% of their dry weight, with an individual maximum of 8%.

(6) Tests of cast stone specimens shall be made in accordance with the "Tentative Specifications for Cast Stone" (Serial Designation P-3-A29T) of the American Concrete Institute.

**Ind 53.05 Building brick.** (1) DEFINITION. By *building brick* is meant a structural unit of burned clay or shale, sand lime or concrete, usually solid and about 8 inches by 3¾ inches by 2¼ inches in size.

(2) STRUCTURE. All building brick shall be rectangular in form, free from cracks, laminations and other defects which may interfere with proper laying of the brick or impair the strength or permanence of the structure.

(3) MANUFACTURE. Concrete building brick shall be manufactured from a mixture of Portland cement and approved aggregates, such as sand, gravel, crushed stone, bituminous or anthracite cinders, burned clay or shale, or blast furnace slag.

(4) IDENTIFICATION. All building brick shall be of distinctive design or appearance, or marked so that the identity of the manufacturer may be known at any time.

(5) STRENGTH AND ABSORPTION. (a) The strength and absorption of all building brick manufactured from burned clay or shale shall conform to the following minimum requirements:

| | Compressive Strength (bricks flatwise) lbs. per square inch Average Gross Area | | Water Absorption by 5 hour boiling per cent | | C/B Ratio | |
|---|---|---|---|---|---|---|
| Grade | Average of 5 bricks | Individual Minimum | Average of 5 bricks | Individual Maximum | Average of 5 bricks | Individual Maximum |
| S.W. | 3000 | 2500 | 17.0 | 20.0 | 0.78 | 0.80 |
| M.W. | 2500 | 2200 | 22.0 | 25.0 | 0.88 | 0.90 |
| N.W. | 1500 | 1250 | No Limit | No Limit | No Limit | No Limit |

1. The ratio C/B is the ratio of absorption by 24-hour submersion in water at room temperature to that after 5-hour submersion in boiling water.

(b) If the average compressive strength is greater than 8000 pounds per square inch and the average water absorption is less than 8% by weight after 24 hours submersion in cold water, the C/B ratio shall be waived.

(6) S. W. BRICK. Grade S. W. brick shall be used in exterior and exposed locations where a high degree of resistance to frost action is desired and the exposure is such that the brick may be frozen when permeated with water.

(a) Brick used for foundation courses, retaining walls, parapet walls and similar locations shall conform to this grade.

(7) M. W. BRICK. Grade M. W. brick may be used where exposed to temperatures below freezing but where brick are not likely to be permeated with water or where a moderate degree of resistance to frost action is permissible.

(a) Brick conforming to this grade may be used in the face of a wall above grade.

(8) N. W. BRICK. Grade N. W. brick may be used for backup or for interior construction or if exposed for use where no frost action occurs.

(9) CONCRETE AND SAND LIME BRICK. The strength of all concrete and sand lime brick used in masonry construction shall conform to the following minimum requirements:

| Compressive Strength (bricks flatwise) Pounds Per Square Inch Average Gross Area | | Modulus of Rupture (bricks flatwise) Pounds Per Square Inch | |
|---|---|---|---|
| Average of 5 Tests | Individual Minimum | Average of 5 Tests | Individual Minimum |
| 2500 | 2000 | 450 | 300 |

(10) TESTS. Typical specimens of all types of building brick shall be tested originally to prove compliance with the provisions of this code, and all concrete and sand-lime brick shall be retested at intervals of not more than one year. Further tests may be demanded at any time there is reasonable suspicion of non-conformance to the requirements of this code.

(11) STANDARDS. The testing of all brick shall be in accordance with the Standard Methods of Testing Brick (A. S. T. M. Designation C 67) of the American Society for Testing Materials.

**Ind 53.06 Hollow building units.** (1) DEFINITIONS. (a) Hollow tile are the products of surface clay, shale, fireclay, or admixtures thereof, moulded to permanent hollow form for use as masonry units in building construction.

(b) Hollow concrete masonry units are the products of Portland cement and suitable aggregates such as sand, gravel, crushed stone,

bituminous or anthracite cinders, burned clay or shale or blast furnace slag, moulded to permanent form for use as masonry units in building construction. Hollow concrete masonry units with applied facings of any type shall conform to the requirements of this code.

(2) HOLLOW TILE USED IN BEARING AND EXTERIOR WALLS. (a) *Strength and absorption.* All hollow tile used in bearing and exterior walls shall conform to the following minimum requirements for strength absorption:

| Compressive Strength (Based on Gross Area) Pounds per Square Inch | | | | Absorption Per cent | | |
|---|---|---|---|---|---|---|
| End Construction Tile | | Side Construction Tile | | | | |
| Average of 5 Tests | Individual Minimum | Average of 5 Tests | Individual Minimum | Average of 5 Tests | Individual Maximum | Individual Minimum |
| 1400 | 1000 | 1000 | 900 | 5 to 16 | 19 | 4 |

(3) NUMBER OF CELLS. Load bearing tile shall conform to the following requirements as to the minimum number of cells per unit in the direction of wall thickness:

| Nominal Horizontal Thickness of Tile as Laid in Wall, in inches | Minimum Number of Cells in Direction of Wall Thickness |
|---|---|
| 4 | 1 |
| 6 | 2 |
| 8 | 2 |
| 10 | 2 |
| 12 | 3 |

*Note:* Cells, as used herein, are hollow spaces enclosed within the perimeter of the exterior shells, and having a minimum dimension of not less than ½ inch and a cross sectional area of not less than one square inch.

(4) DOUBLE-SHELL TILE. In double-shell tile the 2 voids between exterior and interior shells on either side of the tile shall be considered as one cell in thickness of wall when their combined width is not less than ½ inch, provided the short webs between the inner and outer shells are not greater in number and thickness than the long transverse webs holding the inner shells.

(5) SHELL AND WEB THICKNESS. The average over-all thickness of the shells, measured between the inner and extreme outer surfaces of end-construction hollow tile, shall be not less than ¾ inch, except that in double-shell tile the combined average over-all thickness of the inner and outer shell shall be not less than ¾ inch. The thickness of the webs shall be not less than ½ inch.

(6) AVERAGE THICKNESS. The average over-all thickness of the shells, measured between the inner and extreme outer surfaces of side-construction hollow tile, shall be not less than ⅝ inch, except that in double-shell tile the combined average over-all thickness of the inner and outer shell shall be not less than ¾ inch. The thickness of the webs shall be not less than ½ inch.

(7) BRANDING. All clay tile shall be branded with a distinctive indentation on the shell. Clay tile which comply with all requirements for exterior construction and bearing walls shall have the word BEARING impressed on them. All clay tile shall bear the name, initials or trade-mark of the manufacturer.

(8) TESTS. Typical specimens of all sizes and designs of hollow tile used in exterior or bearing walls shall be tested originally to prove compliance with this code, and thereafter as directed by the industrial commission. Tile shall be sampled and tested in accordance with the standard methods of sampling and testing structural clay tile.

*Note:* It will be the policy of the industrial commission to accept methods of sampling and testing structural clay tile as specified by the American Society of Testing Materials. (A.S.T.M. Designation C-112)

(9) HOLLOW CONCRETE MASONRY UNITS. (a) *Compressive strength.* All hollow concrete masonry units shall have a compressive strength of not less than 1000 pounds per square inch gross area as laid in the wall.

1. The average strength of any group of test specimens of hollow concrete masonry units shall not be less than the above requirement. The strength of any individual test specimen shall not be less than 900 pounds per square inch gross area.

(b) *Absorption.* Hollow concrete masonry units shall not absorb more than 14 pounds of water per cubic foot of concrete actually contained.

(c) *Branding.* At least one-third of all hollow concrete masonry units shall be branded with a distinctive indentation or waterproof stencilled mark, which shall bear the name, initials, or trade-mark of the manufacturer. All cubes or piles of block on the job shall be easily identified by branded block which are visible. Producers having more than one plant shall register and use a separate, distinctive brand for each plant. A facsimile of each individual brand shall be filed with the industrial commission.

(d) *Tests.* Typical specimens of all sizes and designs of hollow concrete masonry units shall be tested in an approved manner, originally to prove compliance with the requirements of this code, and thereafter as required by the industrial commission or its authorized agents.

*Note:* It will be the policy of the industrial commission to accept the method of testing as described in A.S.T.M. Designation C-140 "Methods of Sampling and Testing Concrete Masonry Units".

(e) Sampling of hollow concrete masonry units shall be done only by the industrial commission or their authorized agents. The time and place of sampling shall be at the discretion of the industrial commission or their authorized agents. It is intended that such tests will be made at intervals not to exceed one year.

1. At the time of the sampling, the producer or purchaser shall inform the sampling agent of the name and location of the approved testing laboratory to which the samples will be sent for testing. The sampling agent shall notify the industrial commission of the date, number, size, type and seal numbers of the samples selected. Compression tests shall be completed not later than 7 days after sealing. To validate the test, all seals must be accounted for in the laboratory report.

2. Producers having more than one plant will be considered as separate plants with separate samplings and tests for each plant.

(f) Approvals following original tests will remain in effect until later tests show non-conformance with the requirements of this code. To verify compliance with these requirements, the industrial commission may require that tests be made at its designated laboratory.

(g) Non-conformance with the requirements of Wis. Adm. Code section Ind 53.06 shall be determined by the failure of 3 complete tests on a particular job, as tested in an approved manner. In the event of job non-conformance, the necessary structural correction shall be made and the producer shall be barred from supplying any more units on that project.

(h) Testing laboratories must apply annually for certification by the industrial commission. Such certification shall be based on standards established by the industrial commission. Only those tests that are made by a certified laboratory will be accepted. To verify compliance with these standards the industrial commission may require that tests be made at its designated laboratory.

1. The owner or supplier shall have the choice of selecting a certified testing laboratory for any tests at his expense.

(10) CLAY TILE USED IN NON-BEARING PARTITIONS.

(a) *Weight.* The weight of hollow clay tile used in non-bearing partitions shall be not less than the following:

| Dimension | Minimum No. of cells in unit | Minimum No. of cells in direction of wall thickness | Minimum average weight, lb. per sq. ft. of tile | Individual minimum weight, lb. per sq. ft. of tile |
|---|---|---|---|---|
| 2x12x12 | 3 | 1 | 14 | 13 |
| 3x12x12 | 3 | 1 | 15 | 14 |
| 4x12x12 | 3 | 1 | 16 | 15 |
| 6x12x12 | 3 | 1 | 22 | 21 |
| 6x12x12 | 4 | 2 | 25 | 24 |
| 8x12x12 | 4 | 2 | 30 | 28 |
| 10x12x12 | 4 | 2 | 35 | 33 |
| 12x12x12 | 4 | 2 | 40 | 38 |

1. The weights above are for scored tile. If any of the faces are unscored, the weights shall be increased 0.5 lb. per square foot of unscored area.

2. No dimension shall vary more than 3% from the specified dimensions for any form of tile.

3. The requirements for minimum weights of hollow clay tile used in non-bearing partitions shall be waived if the over-all thickness of the shells, measured between the inner and extreme outer surfaces, is not less than ⅝ inch and the thickness of webs is not less than ½ inch.

(b) *Shape and structure.* All hollow clay tile used in non-bearing partitions shall be reasonably free from laminations and from such cracks, blisters, surface roughness and other defects which would interfere with the proper setting of the tile, or impair the strength, permanence or fire protection value of the construction.

1. The depth of curvature or warpage of any face, shall not exceed 3% of the greatest dimension of such face, but in no case more than ¼ inch.

2. Surfaces of all tile intended for the direct application of plaster or stucco shall be scratched or scored. When scored, each groove shall

be not less than ⅛ inch nor more than 3/16 inch in depth, nor more than 1 inch in width. The area covered by the grooves shall not exceed 50% of the area of the scored faces.

(c) *Branding.* All hollow clay tile used in non-bearing partitions shall be branded with a distinctive indentation. All hollow clay tile not suitable for use in bearing and exterior walls but used in non-bearing partitions shall have the word PARTITION impressed on them.

1. All hollow clay tile used in partition work shall bear the name, initials or trade-mark of the manufacturer.

(11) HOLLOW CONCRETE MASONRY UNITS USED IN NON-BEARING PARTITIONS. All hollow concrete masonry units used in non-bearing partitions shall comply with the requirements of Wis. Adm. Code subsection Ind 53.06 (9).

(12) CLAY TILE AND HOLLOW CONCRETE MASONRY UNITS USED IN FLOOR CONSTRUCTION. (a) *General requirements.* Where hollow clay tile are used in concrete floor construction in a way that the whole or any portion of a tile is subjected to a load, the requirements which apply to tile used in exterior and bearing construction shall be complied with. Where hollow concrete masonry units are used in floor construction in a way that the whole or any portion of a block is subjected to a load, the block shall comply with the requirements of Wis. Adm. Code subsection Ind 53.06 (9).

(b) *Tile and masonry floor units.* Where hollow clay tile or hollow concrete masonry units are used in concrete floor construction in a way that no portion of a tile or block is subjected to a load, the requirements which apply to tile or block used in partitions shall apply.

(c) *Branding.* All clay tile or concrete masonry units used in floor construction shall conform to the branding requirements of subsection (9) (c).

History: 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 53.07 Allowable unit stresses in masonry.** (1) The compressive stresses in masonry walls, partitions, piers and similar bearing masonry shall not exceed the following in pounds per square inch:

| Kind of Masonry | Kind of Mortar | | |
|---|---|---|---|
| | Lime | Lime-Portland Cement | Portland Cement |
| Brick | 90 | 140 | 175 |
| Hollow Concrete Masonry Units | ---------- | 85 | 100 |
| Hollow Clay Tile | ---------- | 85 | 100 |

(2) Where a combination of 2 or more building units is used, the minimum requirements shall apply to the masonry.

**Ind 53.08 Mortar.** (1) All cement used in the making of mortar for embedding masonry and for other structural purposes under this code shall conform to the requirements of the standard specifications for these materials issued by the American Society for Testing Materials having designation listed as follows:

Specifications for Portland Cement—C 150–41.

(2) Lime putty for mortar shall be made by slaking quicklime to a smooth paste, and shall be stored and protected for a period of not less than 10 days before being used in the making of mortar. Where pulverized quicklime is used, the storing period may be reduced to 48 hours.

(a) Hydrated lime shall be considered the equivalent of lime putty for all uses hereunder.

(3) Lime mortar shall consist of one part lime putty, or dry hydrated lime, to not more than 3 parts of approved sand, all measurements by volume.

(4) Lime-cement mortar shall consist of one part of lime putty, or dry hydrated lime, and one part of Portland cement added to not more than 6 parts of approved sand, all measurements by volume.

(a) In lime or lime-cement mortars any desired part of the lime may be replaced with an equal volume of Portland cement.

(5) Cement mortar shall consist of one part of Portland cement and not more than 3 parts of approved sand, except that lime putty, or dry hydrated lime, in volume equal to not more than 15% of the volume of Portland cement may be added to the mortar.

*Note:* Approved sand for mortar shall conform to the Tentative Specifications for Concrete Aggregates (A.S.T.M. Designation C33—40) of the American Society for Testing Materials.

**Ind 53.09 Bearing masonry walls, bearing partitions and piers.** (1) GENERAL REQUIREMENTS. All masonry units used in the construction of bearing walls, bearing partitions and piers shall conform in all respects to the requirements for bearing units.

(2) UNIT STRESSES. The unit stresses in bearing masonry walls, partitions and piers shall not exceed those specified in Wis. Adm. Code sections Ind 53.04 and Ind 53.07.

(3) MORTARS. Cement mortar shall be used for all masonry which will have one or more faces in contact with soil. Lime-cement mortar or cement mortar shall be used for all masonry in isolated piers, parapet walls, chimneys where exposed to the weather, and for all hollow masonry units. All other masonry may be laid in cement mortar, lime-cement mortar or lime mortar.

(4) MASONRY BOND. In brick masonry, or in combination brick and other masonry units, the bonding of each tier of units to that adjoining shall be secured by means of a full header course of brick every sixth course of brick, or equivalent. The use of metal ties for bonding masonry is not approved.

(a) By equivalent, is meant that 1/6 of the surface of a wall shall be header, or bond, units.

(b) Where masonry units are larger or smaller than brick, the bond courses shall be placed at intervals not exceeding 16 inches.

(c) Stack bond. Stack bonded masonry units used in the construction of bearing walls and partitions shall be bonded with 3/16 inch diameter steel rods or metal ties of equivalent stiffness embedded in the mortar joints. The vertical distance between ties shall not exceed 16 inches.

(5) USE OF HOLLOW CLAY TILE AND HOLLOW CONCRETE MASONRY UNITS. Approved clay tile and concrete masonry units may be used in

bearing and exterior walls of buildings not more than 3 stories, or 45 feet in height, or in panel walls in buildings of any height. In determining this height, the basement or foundation wall shall be considered a story if constructed of clay tile or concrete masonry units.

(6) LOADING. Concentrated loads shall be transmitted to hollow clay tile or hollow concrete block masonry by at least 3 courses of brick or equivalent concrete or by a metal plate of sufficient thickness and size to distribute the load to the webs and shells in such a manner as not to exceed the unit allowable stress.

(7) PARTY WALL CONSTRUCTION. Where hollow clay tile or hollow concrete masonry units are used in party walls, there shall be not less than 2 such units, each 8 inches in thickness as a minimum, used in making up the thickness of the wall unless solid masonry is used for building all chases, recesses, framing of all openings, and for the support, anchorage, and protection of all joists and beams carried into such wall.

(8) WALL CONSTRUCTION. Clay tile and concrete masonry units used in bearing walls shall be well bedded in mortar. The net bearing area of all clay tile and concrete masonry units as laid in the wall shall be such that the allowable unit stress in the mortar is not exceeded.

(9) SAME. All clay tile laid with cells vertical shall be laid in Portland cement mortar. All clay tile laid with cells horizontal and all concrete masonry units shall be laid in cement-lime mortar, or better.

(10) HEIGHT AND THICKNESS. All bearing walls, party walls and standard division walls, except as hereinafter provided, shall be not less than 12 inches thick in the upper 3 stories, increasing 4 inches in thickness for each 3 stories, or fraction, below. No such 3 story height shall exceed 40 feet.

(11) WALL THICKNESS. A building not more than 3 stories in height may have 8 inch bearing walls in the upper story, provided such story is not more than 10 feet high in the clear, and the span is not more than 20 feet, and the wall is not more than 30 feet long between cross walls, offsets or pilasters.

(12) SAME. A building not more than one story in height may have 8 inch bearing walls, provided the clearstory height is not more than 12 feet, the roof span is not more than 25 feet, and the distance between cross walls, offsets or pilasters is not more than 20 feet.

(a) A building not more than one story in height may have 6-inch bearing walls provided the clearstory height is not more than 9 feet, the roof span is not more than 18 feet and the distance between cross walls, offsets, or pilasters is not more than 15 feet. All other 1-story buildings shall have all bearing walls not less than 12 inches thick.

(13) LATERAL SUPPORT. All bearing masonry walls shall have substantial lateral support at right angles to the wall face at intervals, measured either vertically or horizontally, not exceeding 18 times the wall thickness. Such lateral support shall be obtained by masonry cross walls, piers or buttresses when the limiting distance is measured horizontally, or by floors or roof when the limiting distance is measured vertically.

(14) WALLS BELOW GRADE. Masonry walls which are in contact with the soil in any story shall be increased 4 inches in thickness in that story, except that for places of abode as specified in Wis. Adm. Code section Ind 57.001, not over 2 stories in height, 12 inch walls will be accepted if substantial lateral supports consisting of masonry walls, offsets or pilasters are provided at intervals not to exceed 20 feet.

(15) STONE WALLS. Rubble and rough cut stone walls shall be 4 inches thicker than required for walls of artificially formed units or of ashlar masonry.

(16) SAME. Stone and similar solid facing not less than 4 inches thick may be considered as part of the required thickness of a wall if bonded to the backing as required for brickwork. No such wall shall be less than 12 inches thick.

(17) PIERS. In all buildings, the section of masonry supporting trusses or girders shall be considered as isolated piers, the least dimension of which, in inches, shall be not less than 1/30 of the span of the truss, or girder, in inches, and the height shall not exceed 12 times the minimum horizontal dimension.

(a) The height of masonry piers which are not built into, and as a part of bearing walls, shall be not more than 10 times the minimum horizontal dimension.

(b) Support for long span joist. Where long span steel joist or laminated structural wood members or precast concrete members are used on spans of more than 40 feet, and the spacing exceeds 4 feet, pilasters shall be provided to support each joist or spandrel beam supported on pilasters, or steel columns shall be provided to support the joist.

(18) CHASES, RECESSES AND OPENINGS. There shall be no chases in 8 inch walls or in any pier. No chase in any wall shall be deeper than ⅓ the wall thickness. No horizontal chase shall exceed 4 feet in length nor shall the horizontal projection of any diagonal chase exceed 4 feet. No vertical chase shall be closer than 2 feet to any pilaster, cross wall, end wall or other stiffener.

(a) The aggregate area of recesses and chases in the wall of any one story shall not exceed ¼ the whole area of the face of the wall in that story. No chases or recesses shall be permitted in any wall which will reduce the fire resistance of such wall below the minimum required by this code.

(b) The maximum percentage of openings in the horizontal cross section of any wall shall not exceed 50%, unless the wall is increased 4 inches in thickness, or such portions of the wall between openings shall be as required for piers for the entire wall height.

**History:** 1–2–56; am. (12) (a), Register, June, 1956, No. 6, eff. 7–1–56; am. (4) (b), Register, August, 1957, No. 20, eff. 9–1–57; r. and recr. Register, September, 1959, No. 45, eff. 10–1–59.

**Ind 53.10 Non-bearing masonry walls.** (1) GENERAL REQUIREMENTS. All exterior non-bearing masonry walls if constructed with one course of brick to the weather may be backed with common brick, concrete masonry units, or non-bearing clay tile, conforming to the requirements of Wis. Adm. Code sections Ind 53.05 and Ind 53.06. If walls are built of concrete masonry units or clay tile, with or without ex-

terior stucco, such walls shall be constructed of concrete masonry units or clay tile conforming to the requirements of Wis. Adm. Code section Ind 53.06.

(2) INTERIOR NON-BEARING WALLS. Interior non-bearing partition walls may be built of materials conforming to the requirements of Wis. Adm. Code sections Ind 53.05 and Ind 53.06, or of gypsum block or other approved materials.

(3) TYPE OF MORTAR. Lime, lime-cement or cement mortar shall be used for all non-bearing masonry, except as follows:

(a) Lime mortar shall not be used in normally wet or damp locations.

(b) Gypsum shall be used for gypsum masonry.

(c) Gypsum may be used for interior clay tile masonry.

(4) MASONRY BOND AND ANCHORAGE. In non-load bearing brick masonry or in combinations of brick and other masonry units, the bonding of each tier of units to that adjoining, shall be secured by means of a full header course of brick or other units placed at intervals not exceeding 32 inches. The height of such bond course shall not exceed 5 inches and the width of bed joint used to effect the masonry bond shall be at least 4 inches.

(a) All exterior and interior non-bearing walls and partitions shall be securely anchored to supporting members by means of corrosion resistant ties of at least No. 13 U.S. Standard Gauge metal spaced not more than 18 inches center to center.

(b) Stack bond. Stack bonded masonry units used in the construction of non-load bearing walls and partitions shall be bonded with 3/16 inch steel rods or metal ties of equivalent stiffness embedded in the mortar joint. The vertical distance between ties shall not exceed 32 inches.

(c) Masonry veneer on frame structures shall be securely anchored to the structure with corrosion resistant ties of at least No. 13 U.S. Standard Gauge metal or equal. The maximum vertical distance between ties shall not exceed 18 inches and the maximum horizontal distance shall not exceed 36 inches and the ties in alternate courses shall be staggered.

(5) HEIGHT AND THICKNESS. Interior non-bearing masonry walls which are supported by fire-resistive construction and have tight contact with not less than 2-hour fire-resistive construction at the top, shall be not more than 36 times their thickness in clear height. Similar non-bearing walls which contact less than 2-hour fire-resistive support at the top shall be not more than 24 times their thickness in clear height. Plastering shall be included in computing the thickness.

(6) THICKNESS OF EXTERIOR NON-BEARING WALLS. The thickness of exterior non-bearing walls shall be not less than 1/24 of the clear height and not less than 1/30 of the horizontal distance between vertical supports, but in no case less than 8 inches.

**History:** 1-2-56; r. and recr. Register, September, 1959, No. 45, eff. 10-1-59.

**Ind 53.11 Cavity walls.** (1) Exterior non-bearing walls may be built with a facing of 4 inches of building brick complying with the requirements of Wis. Adm. Code section Ind 53.05, and a backing

of either building brick complying with the requirements of Wis. Adm. Code section Ind 53.05, or hollow building units complying with the requirements of Wis. Adm. Code section Ind 53.06. Such walls shall have an air space between the facing and backing of not less than 2 inches nor more than 2½ inches, and shall be bonded to each other with galvanized metal ties at least ¼ inch thick every 16 inches in height and 24 inches in width. The maximum height between supports shall be 10 feet. For heights greater than 10 feet between supports, the thickness of the backing shall be increased 2 inches for each 5 feet, or fraction thereof. The wall shall be anchored to the supporting framework with metal ties at least ⅛ inch thick, spaced not more than 24 inches center to center.

(2) A waterproofing membrane shall be installed at the bottom of the wall cavity. It shall pass through both the exterior facing course and the backing in such a manner as to drain outward the water which might penetrate the facing. Open vertical joints, or weep holes, shall be provided every 3 feet horizontally in the facing above the membrane.

**Ind 53.12 Bonding and anchoring stone and cast stone veneers.** (1) For bearing walls, stone shall be bonded to the backing every 16 inches of wall height with bond courses at least 4 inches in height, and the width of bed joint used to effect the masonry bond shall be at least 4 inches.

(2) For non-bearing walls, individual stones shall be anchored to the supporting framework and dowelled to each other at all horizontal joints, and anchored to the backing at all horizontal joints and at vertical joints so that one anchor is provided for every 6 square feet of wall surface. All anchors shall be not less than ¼ square inch in cross section and made of wrought iron galvanized after forming, or of commercial bronze.

(3) The backing of all stone or cast stone bearing or non-bearing walls shall be of brick conforming to the requirements of section Ind 53.05 or other solid material weighing at least 130 pounds per cubic foot except where the stone facing is not more than 4 inches in thickness, the backing may be of hollow masonry units conforming to the requirements of section Ind 53.06, or other similar non-corrosive material.

**History:** 1-2-56; r. and recr. Register, September, 1959, No. 45, eff. 10-1-59.

**Ind 53.13 Parapet walls.** (1) Parapet walls not less than 8 inches in thickness and 2 feet in height shall be provided on all exterior walls of masonry or concrete, where such walls connect with roofs other than roofs that are of incombustible construction throughout; but this section shall not apply:

(a) To buildings where frame construction would be permitted under the provisions of this code.

(b) To walls which face streets, or alleys.

(c) To walls where not less than 10 feet of vacant space is maintained between the wall and the boundary line between premises.

(d) To walls which are not less than 10 feet from other buildings on the same premises.

(2) All parapet walls shall be properly coped with incombustible, weatherproof material.

(3) Parapet walls not less than 8 inches in thickness and 3 feet in height shall be provided on all division and party walls of masonry or concrete where such walls connect with roofs of other than 2-hour fire-resistive construction, or better.

**History:** 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 53.14 Concrete materials.** (1) PORTLAND CEMENT. Portland cement shall conform to the "Standard Specifications for Portland Cement" (A.S.T.M. Serial Designation: C-150-49).

(2) CONCRETE AGGREGATES. Concrete aggregates, except lightweight aggregates, shall conform to the "Standard Specifications for Concrete Aggregates" (A.S.T.M. Designation C-33-49) including the method of sampling and testing.

(3) LIGHTWEIGHT AGGREGATES. Lightweight aggregates for concrete shall conform to the "Standard Specifications for Lightweight Aggregates for Concrete" (A.S.T.M. Designation C-130-42) including the methods of sampling and testing.

(a) The maximum size of the aggregate shall not be larger than ⅕ of the narrowest dimension between sides of the forms of the member for which the concrete is to be used nor larger than ¾ of the minimum clear spacing between reinforcing bars.

(4) WATER. Water used in mixing concrete shall be clean, and free from injurious amounts of oil, acid, alkali, organic matter, or other harmful substances.

(5) METAL REINFORCEMENT. Metal reinforcement shall conform to the requirements of the "Standard Specifications for Billet-Steel Bars for Concrete Reinforcement" (A.S.T.M. Serial Designation: A15-50T) or for "Rail Steel Bars for Concrete Reinforcement" (A.S.T.M. Serial Designation: A16-50T) or for "Welded Steel Wire Fabric for Concrete Reinforcement" (A.S.T.M. Serial Designation A-185-37).

(a) *Deformed bars.* Deformed reinforcing bars shall conform to the "Standard Specifications for Minimum Requirements for the Deformations of Deformed Steel Bars for Concrete Reinforcement" (A.S.T.M. Serial Designation: A-305-50T). Bars not conforming to these specifications shall be classed as plain bars.

(b) *Wire mesh.* Wire mesh with welded intersections not further apart than 6 inches in the direction of the principal reinforcement and with cross wires not smaller than No. 10 W and M gauge may be rated as deformed bars.

(c) *Placing metal reinforcement.* Metal reinforcement shall be accurately placed and adequately secured in position by concrete or metal chairs or spacers. The minimum clear distance between parallel bars, except in columns, shall be equal to the nominal diameter of the bars. In no case shall the clear distance between the bars be less than one inch, nor less than one and one-third the maximum size of the coarse aggregate. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall not be less than one inch and the bars in the upper layers shall be placed directly above those in the bottom layer.

(6) STORAGE OF MATERIALS. Cement and aggregates shall be stored in such a manner as to prevent deterioration or the intrusion of foreign matter. Any material which has deteriorated or which has been damaged shall be removed completely from the premises.

**Ind 53.15 Concrete proportions, mixing and strength.** (1) PROPORTIONS. The proportions of aggregate to cement for any concrete shall be such as to produce a mixture which will work readily into the corners and angles of the forms and around reinforcement with the method of placing employed on the work, but without permitting the materials to segregate or excess free water to collect on the surface.

(a) The methods of measuring concrete materials shall be such that the proportions can be controlled accurately and checked easily at any time during the work. Wherever practicable, such measurement shall be by weight rather than by volume.

(2) MIXING. The concrete shall be mixed until there is a uniform distribution of the materials and the mass is uniform in color and homogeneous. In machine mixing, only batchmixers shall be used. Each batch shall be mixed not less than one minute after all the materials are in the mixer and must be discharged completely before the mixer is recharged. Machine mixers shall have a peripheral speed of approximately 200 feet per minute.

(a) Ready-mixed concrete shall be mixed and delivered in accordance with the requirements set forth in the "Standard Specifications for Ready-mixed Concrete" (A.S.T.M. Serial Designation C94-48).

(3) STRENGTH. For the design of reinforced concrete structures, the value of $f'_c$ used for determining the working stresses as stipulated in Wis. Adm. Code subsection Ind 53.22 (3) shall be based on the specified minimum 28-day compressive strength of the concrete, or on the specified minimum compressive strength at the earlier age at which the concrete may be expected to receive its full load. All plans, submitted for approval or used on the job, shall show clearly the assumed strength of concrete at the specified age for which all parts of the structure were designed.

(a) All concrete exposed to the action of the weather shall have a water-content of not to exceed 6 gallons per sack of cement.

(b) When average aggregates are to be used and no preliminary tests are to be made, the water content to be used for various desired strengths of concrete shall be as indicated in the following table:

| Water-Content, U. S. Gallons per 94 lb. Sack of Cement | 7½ | 6¾ | 6 |
|---|---|---|---|
| Assumed Compressive Strength at 28 Days, lb. per sq. in. | 2000 | 2500 | 3000 |

(c) In computing the water-content, surface water carried by the aggregates must be included. Water-content other than shown in the above table may be used, provided that the strength-quality of the concrete proposed for use in the structure shall be established by tests made in advance of the start of the work, using suitable con-

sistencies and in accordance with the "Standard Method of Making Compression Tests of Concrete" (A.S.T.M. Serial Designation: C39–49).

(d) A curve representing the relation between the water-content and the average 28-day compressive strength or earlier strength at which the concrete is to receive its full working load, shall be established for a range of values including all the compressive strengths indicated on the plans.

(e) The curve shall be established by at least 3 points, each point representing average values from at least 4 test specimens. The maximum allowable water-content for the concrete for the structure shall be as determined from this curve and shall correspond to a strength which is 15% greater than that indicated on the plans. No substitutions shall be made in the materials used on the work without additional tests in accordance herewith to show that the quality of the concrete is satisfactory.

(4) CURING AND PROTECTION AGAINST COLD WEATHER. In all concrete structures, concrete made with normal Portland cement shall be maintained in a moist condition for at least the first 7 days after placing, and high-early-strength concrete shall be so maintained for at least the first 3 days.

(a) Adequate equipment shall be provided for heating the concrete materials and protecting the concrete during freezing weather. No frozen materials or materials containing ice shall be used.

(b) All concrete materials and all reinforcements, forms, fillers, and ground with which the concrete is to come in contact, shall be free from frost. Whenever the temperature of the surrounding air is below 40 degrees Fahrenheit, all concrete when placed in the forms shall have a temperature of between 60 and 90 degrees Fahrenheit and shall be maintained at a temperature of not less than 50 degrees Fahrenheit for at least 72 hours for normal concrete or 24 hours for high-early-strength concrete, or for as much more time as is necessary to insure proper rate of curing of the concrete. The housing, covering or other protection used in connection with curing shall remain in place and intact at least 24 hours after the artificial heating is discontinued. No dependence shall be placed on salt or other chemicals for the prevention of freezing.

(5) FORMS AND SHORING FOR CONCRETE STRUCTURES. Forms shall be substantially constructed to carry dead and live loads and impact imposed during pouring operations. Forms shall conform to the shape, lines, and dimensions of the members as called for on the plans, and shall be sufficiently tight to prevent leakage of mortar. They shall be properly braced or tied together so as to maintain position and shape.

(a) Forms shall be removed in such manner as to insure the complete safety of the structure. Where the structure as a whole is supported on shores, the removable floor forms, beam and girder sides, column and similar vertical forms may be removed after 24 hours, provided the concrete is sufficiently hard not to be injured thereby. In no case shall the supporting forms or shoring be removed until the members have acquired sufficient strength to support safely their weight and the load thereon. The results of suitable control tests may be used as evidence that the concrete has attained such sufficient strength.

**Ind 53.16 Flexure of beams, frames, and slabs.** (1) CONDITION OF DESIGN. All members of frames or continuous construction shall be designed to resist at all sections the maximum moments and shears produced by dead load, live load and wind load, as determined by some one of the approximate methods of elastic frame analysis. Any reasonable assumptions may be adopted as to relative stiffness of columns and floor members. The assumptions made should be consistent throughout the analysis. The following will serve as a guide to satisfactory design.

(a) The stiffness, K, of a member is defined as EI divided by l or h. The modulus of elasticity for concrete shall be assumed as 1000 $f'_c$, and that for steel as 30,000,000 lbs. per sq. in. In the analysis of continuous frames, center to center distances, l and h, shall be used in the determination of moments.

(b) In computing the value of I of slabs, beams, girders, and columns, the reinforcement may be neglected. In T-shaped sections allowance shall be made for the effect of the flange. The additional width of haunched floor members near supports may be neglected in computing moments, but may be considered to resist moment and shear. The additional depth of haunched floor members may be considered as resisting moment only when a complete analysis is made taking into account the variation in depth. Otherwise the minimum depth should be used to find moment and to resist the resulting moment. However, in any case, the actual depth may be assumed to resist shear.

(c) Moments at faces of supports may be used for design of beams and girders. Solid or ribbed slabs with clear spans of not more than 10 feet that are built integrally with their supports may be designed as continuous slabs on knife edge supports with spans equal to the clear spans of the slab and the width of beams otherwise neglected. The span length of members that are not built integrally with their supports shall be the clear span plus the depth of the beam or slab but shall not exceed the distance between centers of supports.

(d) The clear distance between lateral supports of a beam shall not exceed 32 times the least width of compression flange.

(2) REQUIREMENTS FOR T-BEAMS. In T-beam construction, the slab and beam shall be built integrally or otherwise effectively bonded together. The effective flange width to be used in the design of symmetrical T-beams shall not exceed ¼ of the span length of the beam, and its overhanging width on either side of the web shall not exceed 8 times the thickness of the slab nor ½ the clear distance of the next beam.

(a) For beams having a flange on one side only, the effective overhanging flange width shall not exceed $\frac{1}{12}$ of the span length of the beam, nor 6 times the thickness of the slab, nor ½ the clear distance to the next beam.

(b) Where the principal reinforcement in a slab which is considered as the flange of a T-beam (not a joist in concrete joist floors) is parallel to the beam, transverse reinforcement shall be provided in the top of the slab. This reinforcement shall be designed to carry the load on the portion of the slab assumed as the flange of the T-beam. The spacing of the bars shall not exceed 5 times the thickness of the flange, nor in any case 18 inches.

(c) Provision shall be made for the compressive stress at the support in continuous T-beam construction, care being taken that the provisions relating to the spacing of bars, and the placing of concrete shall be fully met.

(d) The overhanging portion of the flange of the beam shall not be considered as effective in computing the shear and diagonal tension resistance of T-beams.

(e) Isolated beams in which the T-form is used only for the purpose of providing additional compression area, shall have a flange thickness of not less than ½ the width of the web and a total flange width not more than 4 times the web thickness.

(3) COMPRESSION STEEL IN FLEXURAL MEMBERS. Compression steel in beams, girders, or slabs shall be anchored by ties or stirrups not less than ¼ inch in diameter spaced not farther apart than 16 bar diameters, or 48 tie diameters. Such stirrups or ties shall be used throughout the distance where the compression steel is required.

(4) CONCRETE JOIST FLOOR CONSTRUCTION. Concrete joist floor construction consists of concrete joists and slabs placed monolithically with or without burned clay or concrete tile fillers. The joists shall not be farther apart than 30 inches face to face. The joists shall be not less than 4 inches wide, nor of a depth more than 3 times the width.

(a) When burned clay or concrete tile fillers, of material having a unit compressive strength at least equal to that of the designed strength of the concrete in the joists are used, and the fillers are so placed that the joints in alternate rows are staggered, the vertical shells of the fillers in contact with the joists may be included in the calculations involving shear or negative bending moment. No other portion of the fillers may be included in the design calculations.

(b) The concrete slab over the fillers shall be not less than one and one-half inches in thickness, nor less in thickness than $\frac{1}{12}$ of the clear distance between joists.

(c) Where removable forms or fillers are used, the thickness of the concrete slab shall not be less than $\frac{1}{12}$ of the clear distance between joists and in no case less than 2 inches. Such slab shall be reinforced at right angles to the joists with a minimum of .049 sq. in. of reinforcing steel per foot of width, and in slabs on which the prescribed live load does not exceed 50 lbs. per sq. ft., no additional reinforcements shall be required.

(d) When the finish used as a wearing surface is placed monolithically with the structural slab in buildings of the warehouse or industrial class, the thickness of the concrete over the fillers shall be ½ inch greater than the thickness used for design purposes.

(e) Where the slab contains conduits or pipes, the thickness shall not be less than ½ inch plus the total over-all depth of such conduits or pipes at any point. Such conduits or pipes shall be so located as not to impair the strength of the construction.

(5) FLAT SLABS AND TWO-WAY SLABS WITH SUPPORTS ON 4 SIDES. Structures of these types shall be designed in accordance with the provisions of the 1940 Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, or the building regulations for reinforced concrete of the American Concrete Institute (A.C.I. 318–56).

**Ind 53.17 Shear and diagonal tension.** (1) GENERAL. Due to the composite character of reinforced concrete beams, the action of reinforcement in resisting diagonal tension is not susceptible of exact analysis. Hence, the design of web reinforcement is based on empirical or modified rational methods which have been developed from tests and the observations of existing structures.

(a) Vertical stirrups, bent-up longitudinal bars or both, add greatly to the resistance to shear or diagonal tension. This is especially true if adequate bond resistance is provided, either in the form of low bond stress or effective anchorage of the reinforcement. The importance of bond resistance is such that high working stresses are permitted only when all of the reinforcement is anchored properly. Therefore, the requirements of Wis. Adm. Code section Ind 53.18 on bond and anchorage are intimately related to the provisions of this section.

(2) UNIT SHEARING STRESS. The shearing unit stress used as a measure of diagonal tension shall be computed by the formula $v=\frac{V}{bjd}$. For beams of I or T section, the width of the concrete web or stem shall be used.

(a) In concrete joist floor construction where burned clay or concrete tile are used, the shells of the tile in contact with the joists may be used in computing the shearing stress provided that the net compressive strength of the shells of tile equals that of the concrete in the joists and provided that the joints in alternate rows of tile are staggered.

(3) USE OF WEB REINFORCEMENT. Where the shearing unit stress in a beam or joist exceeds 0.03 $f'_c$, web reinforcement shall be provided at all sections for the shear in excess of this amount.

(a) Web reinforcement may consist of vertical or inclined stirrups or bent-up longitudinal reinforcement or a combination thereof. Bars inclined at an angle less than 15 degrees with the axis of the beam shall not be considered as web reinforcement.

(b) Stirrups or bent-up longitudinal bars to be considered effective as web reinforcement shall be anchored at both ends in accordance with the requirements of Wis. Adm. Code section Ind 53.18.

(4) SPACING OF WEB REINFORCEMENT. Where web reinforcement is required, it shall be spaced that every 45 degree line (representing a potential crack) extending from the mid-depth of the beam to the longitudinal tension bars shall be crossed by at least one line of web reinforcement. If a shearing unit stress in excess of 0.06 $f'_c$ is used, every such line shall be crossed by at least 2 such lines of web reinforcement.

**Ind 53.18 Bond and anchorage.** (1) UNIT BOND STRESS. In flexual members in which the tensile reinforcement is parallel to the compression face, the bond stress at any cross section shall be computed by the formula $u=\frac{V}{\Sigma o\, jd}$. In beams of variable depth to which this formula does not apply, special provision must be made for the end anchorage of all tensile reinforcement.

(2) ANCHORAGE FOR LONGITUDINAL STEEL AND WEB REINFORCEMENT. Tensile negative reinforcement in any span of a continuous restrained or cantilever beam, or in any member of a rigid frame shall be ade-

quately anchored by bond, hooks or mechanical anchors in or through the supporting member. Within any such span, every reinforcing bar, whether required for positive or negative reinforcement, shall be extended at least 12 diameters beyond the point at which it is no longer needed to resist stress. The maximum tension in any bar must be developed by bond on a sufficient straight or bent embedment or by other anchorage. If preferred, the bar may be bent across the web at an angle of not less than 15 degrees with the longitudinal portion of the bar and made continuous with the reinforcement which resists moment of opposite sign.

(a) Of the positive reinforcement in continuous beams not less than ¼ of the area shall extend along the same face of the beam into the support a distance of 6 inches.

(b) In simple beams, or at the freely supported end of continuous beams, at least ⅓ the required positive reinforcement shall extend along the same face of the beam into the support a distance of 6 inches.

(c) Plain bars in tension shall terminate in standard hooks except that hooks shall not be required on the positive reinforcement at interior supports of continuous members.

(d) Single separate bars used as web reinforcement shall be anchored at each end by one of the following methods:

1. By welding to longitudinal reinforcement.
2. By hooking tightly around the longitudinal reinforcement through 180 degrees.
3. The extreme ends of bars forming simple U or multiple stirrups shall be anchored as specified in 1 or 2 or shall be bent through an angle of 90 degrees tightly around a longitudinal reinforcing bar not less in diameter than the stirrup bar and shall project beyond the bend at least 12 diameters of the stirrup bar.
4. In all cases, web reinforcements shall be carried as close to the compression surface of the beam as fire and rust protection regulations and the proximity of other steel will permit.

Ind 53.19 Columns. (1) LIMITING DIMENSIONS. The following sections apply to a short column, for which the unsupported height is not greater than 10 times the least lateral dimension. When the unsupported height exceeds this value, the design shall be modified as shown in Wis. Adm. Code section Ind 53.19. The unsupported height may be defined as the distance from the bottom of a slab, column capital, or beam to the top of the floor below.

Principal columns in buildings shall have a minimum diameter of 10 inches. Rectangular columns shall have a minimum thickness of 8 inches and a minimum gross area of 120 square inches.

Posts, bearing walls, piers, or mullions that are not continuous from story to story shall have a minimum diameter or thickness of 6 inches.

(2) SPIRAL COLUMNS. The maximum allowable axial load on columns reinforced with longitudinal bars and closely spaced spirals enclosing a circular core shall be as follows:

$$P = A_g\ (0.225\ f'_c + f_s p_s)$$

Wherein

$A_g$ = The gross area of the column.

$f'_c$ = Compressive strength of the concrete.

$f_s$ = Nominal allowable stress in vertical column reinforcement to be taken at 40% of the minimum specification value of the yield point; namely, for rail or hard grade steel—20,000#; for intermediate grade steel—16,000#.

$p_s$ = Ratio of the effective cross sectional area of vertical reinforcement to the gross area $A_g$. The ratio $p_s$ shall not be less than 0.01 nor more than 0.08.

(a) *Vertical bars.* The minimum number of vertical bars shall be 6, and the minimum diameter of bar shall be ⅝ inch. Spirals shall be at least ¼ inch in diameter and shall not be spaced less than 1½ inches nor more than 3 inches apart.

(b) *Spiral reinforcement.* The ratio of spiral reinforcement $p'$ shall not be less than the value given by the following formula:

$$p' = 0.45 \left( \frac{A_g}{A_c} - 1 \right) \frac{f'_c}{f'_s}$$

Wherein

$p'$ = Ratio of volume of spiral reinforcement to the volume of the concrete core (out to out of spirals).

$f'_s$ = Useful limit stress of spiral reinforcement to be taken as 40,000# per sq. in. for hot rolled rods of intermediate grade, 50,000# per sq. in. for rods of hard grade, and 60,000# per sq. in. for cold drawn wire.

(3) TIED COLUMNS. The maximum allowable axial load on columns reinforced with longitudinal bars and separate lateral ties shall be 80% of that given by the formula for spirally reinforced columns.

(a) The minimum number of vertical bars shall be 4, and the minimum diameter of bar shall be ⅝ inch. Lateral ties shall be at least ¼ inch in diameter and shall be spaced apart not over 16 bar diameters, 48 tie diameters, or the least dimension of the column. When there are more than 4 vertical bars, additional ties shall be provided so that every longitudinal bar is held firmly in its designed position.

(4) LONG COLUMNS. The maximum allowable load $P'$ on an axially loaded reinforced concrete column having a height, h, greater than 10 times its least lateral dimension, d, is given by the formula:

$$P' = P \left[ 1.3 - .03 \frac{h}{d} \right]$$

in which P = the allowable axial load on a normal short column.

(5) BENDING MOMENTS IN COLUMNS. Columns in building frames shall be designed to resist the maximum moments and shears produced by dead load, live load, and wind load, as determined by some approximate method of elastic frame analysis. Assumptions as to relative rigidity of columns and floor members shall be consistent throughout and agree with the methods used in the analysis of floor members. Recognized methods of analysis shall be followed in calculating the stresses due to combined axial load and bending. The gross area of both spiral and tied columns may be used in these computations.

(a) Where lapped splices in the column verticals are used, the minimum amount of lap shall be as follows:

1. For deformed bars with concrete having a strength of 3,000# per sq. in. or above, 20 diameters of bar of intermediate or hard grade steel. For bars of higher yield point, the amount of lap shall be increased one diameter for each 1,000# per sq. in. by which the allowable stress exceeds 20,000# per sq. in. When the concrete strengths are less than 3,000# per sq. in., the amount of lap shall be ⅓ greater than the values given above.

2. For plain bars, the minimum amount of lap shall be twice that specified for deformed bars.

3. Welded splices or other positive connections may be used instead of lapped splices. Welded splices shall preferably be used in cases where the bar diameter exceeds 1¼ inches. An approved welded splice shall be defined as one in which the bars are butted and welded and that will develop in tension at least the yield point stress of the reinforcing steel used.

History: 1–2–56; am. Register, December, 1962, No. 84, eff. 1–1–63.

**Ind 53.20 Plain and reinforced concrete walls and piers.** (1) Definitions. Plain concrete walls shall be defined as concrete walls where the area of the horizontal reinforcement is less than 0.0025 and the area of the vertical reinforcement is less than 0.0015 times the cross sectional area of the wall where bars are used and not less than ¾ this amount where welded wire fabric of not less than No. 10 A. S. & W. gauge is used.

(2) Thickness. The thickness of reinforced concrete bearing walls shall not be less than 6 inches for the upper 15 feet of their height, and for each successive 25 feet downward, the minimum thickness shall be increased 1 inch.

(a) Reinforced concrete bearing walls shall have a thickness of not less than 1/25 of the unsupported height or width, whichever is the shorter.

(b) Exterior basement walls, foundation walls, and party walls of either plain or reinforced concrete shall be not less than 8 inches thick.

(c) The limit of thickness and quantity of reinforcement may be waived when structural analysis shows adequate strength and stability, if approved by the industrial commission.

(3) Working stresses. The allowable working stresses in reinforced concrete bearing walls with minimum reinforcement specified above shall be 0.25 $f'_c$ for walls having a ratio of height to thickness of 10 or less and shall be reduced proportionally to 0.15 $f'_c$ for walls having a ratio of height to thickness of 25. When the reinforcement in bearing walls is designed, placed, and anchored in position as for tied columns, the allowable working stresses for tied columns may be used. The length of wall to be considered effective for each concentrated load shall not exceed the width of the bearing plus 4 times the wall thickness, nor shall it exceed the center to center distance between loads. The ratio $p'_g$ shall not exceed 0.04.

(4) Non-bearing walls. Non-bearing panel and enclosure walls of reinforced concrete shall have a thickness of not less than 4 inches and not less than 1/30 the distance between supporting or enclosing members.

History: 1–2–56; r. and recr. Register, August, 1957, No. 20, eff. 9–1–57.

**Ind 53.21 Footings.** (1) BENDING MOMENT. The external moment on any section shall be determined by passing through the section a vertical plane which extends completely across the footing, and computing the moment of the forces acting over the entire area of the footing on one side of said plane.

(a) The greatest bending moment to be used in the design of an isolated footing shall be the moment computed in the manner just described at sections located as follows:

1. At the face of the column, pedestal or wall, for footings supporting a concrete column, pedestal or wall.

2. Halfway between the middle and the edge of the wall, for footings under masonry walls.

3. Halfway between the face of the column or pedestal and the edge of the metallic base, for footings under metallic bases.

4. The width resisting compression at any section shall be assumed as the entire width of the top of the footing at the section under consideration.

(b) In one-way reinforced footings, the total tensile reinforcement at any section shall provide a moment of resistance at least equal to the bending moment and the reinforcement thus determined shall be distributed uniformly across the full width of the section.

(c) In two-way reinforced footings, the total tensile reinforcement at any section shall provide a moment of resistance at least equal to 85% of the bending moment.

(d) In two-way square footings, the reinforcement extending in each direction shall be distributed uniformly across the full width of the footing.

(e) In two-way rectangular footings, the reinforcement in the long direction shall be distributed uniformly across the full width of the footing. In the case of the reinforcement in the short direction, that portion determined by the following formula shall be uniformly distributed across a band-width (B) centered with respect to the center line of the column or pedestal and having a width equal to the length of the short side of the footing. The remainder of the reinforcement shall be uniformly distributed in the outer portions of the footing.

$$\frac{\text{Reinforcement in band-width (B)}}{\text{Total reinforcement in short dimension}} = \frac{2}{(S+1)}$$

In this formula, "S" is the ratio of the long side to the short side of the footing.

(2) ANCHORAGE OF BARS IN FOOTING SLABS. Plain bars in footing slabs shall be anchored by means of standard hooks. The outer faces of these hooks and the ends of deformed bars shall not be less than 3 inches nor more than 6 inches from the face of the footing.

(3) SHEAR AND BOND. The critical section for shear to be used as a measure of diagonal tension shall be assumed as a vertical section obtained by passing a series of vertical planes through the footing,

each of which is parallel to a corresponding face of the column, pedestal, or wall and located a distance therefrom equal to the effective depth for footings on soil, and ½ the effective depth for footings on piles.

(a) Each face of the critical section as defined above shall be considered as resisting an external shear equal to the load on an area bounded by said face of the critical section for shear, 2 diagonal lines drawn from the column or pedestal corners and making 45 degree angles with the principal axes of the footing, and that portion of the corresponding edge or edges of the footing intercepted between the 2 diagonals.

(b) Critical sections for bond shall be assumed at the same planes as those prescribed for bending moment; also at all other vertical planes where changes of section or of reinforcement occur.

(c) Computations for shear to be used as a measure of bond shall be based on the same section and loading as prescribed for bending moment.

(d) The total tensile reinforcement at any section shall provide a bond resistance at least equal to the bond requirement as computed from the following percentages of the external shear at the section:

1. In one-way reinforced footings, 100%.
2. In two-way reinforced footings, 85%.

(e) In computing the external shear on any section through a footing supported on piles, the entire reaction from any pile whose center is located 6 inches or more outside the section shall be assumed as producing shear on the section; the reaction from any pile whose center is located 6 inches or more inside the section shall be assumed as producing no shear on the section. For intermediate positions of the pile center, the portion of the pile reaction to be assumed as producing shear on the section shall be based on straightline interpolation between full value at 6 inches outside the section and zero value of 6 inches inside the section.

(4) TRANSFER OF STRESS AT BASE OF COLUMN. The stress in the longitudinal reinforcement of a column or pedestal shall be transferred to its supporting pedestal or footing either by extending the longitudinal bars into the supporting member, or by dowels.

(a) In case the transfer of stress in the reinforcement is accomplished by extension of the longitudinal bars, they shall extend into the supporting member the distance required to transfer to the concrete, by allowable bond stress, their full working value.

(b) In cases where dowels are used, their total sectional area shall be not less than the sectional area of the longitudinal reinforcement in the member from which the stress is being transferred. In no case shall the number of dowels per member be less than 4 and the diameter of the dowels shall not exceed the diameter of the column bars by more than ⅛ inch.

(c) Dowels shall extend up into the column or pedestal a distance at least equal to that required for lap of longitudinal column bars

and down into the supporting pedestal or footing the distance required to transfer to the concrete, by allowable bond stress, the full working value of the dowel.

(d) The compressive stress in the concrete at the base of a column or pedestal shall be considered as being transferred by bearing to the top of the supporting pedestal or footing. The unit compressive stress on the loaded area shall not exceed the bearing stress allowable for the quality of concrete in the supporting member as limited by the ratio of the loaded area to the supporting area.

(e) In sloped or stepped footings, the supporting area for bearing may be taken as the top horizontal surface of the footing, or assumed as the area of the lower base of the largest frustum of a pyramid or cone contained wholly within the footing and having for its upper base the area actually loaded, and having side slopes of one vertical to 2 horizontal.

(5) PEDESTALS AND FOOTINGS (PLAIN CONCRETE). The allowable compressive unit stress on the gross area of a concentrically loaded pedestal shall not exceed 0.25 $f'_c$. Where this stress is exceeded, reinforcement shall be provided and the member designed as a reinforced concrete column.

(a) The depth and width of a pedestal or footing of plain concrete shall be such that the tension in the concrete shall not exceed .03 $f'_c$ and the average shearing stress shall not exceed .02 $f'_c$ taken on sections as prescribed heretofore for reinforced concrete footings.

(6) FOOTINGS SUPPORTING ROUND COLUMNS. In computing the stresses in footings which support a round or octagonal concrete column or pedestal, the "face" of the column or pedestal shall be taken as the side of a square having an area equal to the area enclosed within the perimeter of the column or pedestal.

(7) MINIMUM EDGE-THICKNESS. In reinforced concrete footings, the thickness above the reinforcement at the edge shall be not less than 6 inches for footings on soil, nor less than 12 inches for footings on piles.

(a) In plain concrete footings, the thickness at the edge shall be not less than 8 inches for footings on soil, nor less than 14 inches above the tops of the piles for footings on piles.

**Ind 53.22 Allowable working stresses.** (1) CONCRETE STRENGTH. The strength of concrete is fixed by the water content as described in Wis. Adm. Code subsection Ind 53.15 (3). Reinforced concrete used under this code shall have a compressive strength of at least 2000# per sq. in. and no credit shall be given for strengths in excess of 3000# per sq. in. unless approved in writing by the industrial commission.

(2) MODULAR RATIO. The modular ratio, n, shall be assumed equal to $n = \frac{30{,}000}{f'_c}$.

(3) ALLOWABLE UNIT STRESSES IN CONCRETE.

| Description | | Allowable unit stresses | | | | |
|---|---|---|---|---|---|---|
| | | For any strength of concrete in accordance with Section Ind 53.15(2) $n = \frac{30,000}{f'_c}$ | Maximum value psi | For strength of concrete shown below | | |
| | | | | $f'_c = 2000$ psi $n = 15$ | $f'_c = 2500$ psi $n = 12$ | $f'_c = 3000$ psi $n = 10$ |
| Flexure: $f_c$ | | | | | | |
| Extreme fiber stress in compression | $f_c$ | $0.45f'_c$ | ------- | 900 | 1125 | 1350 |
| Extreme fiber stress in tension in plain concrete footings | $f_c$ | $0.03f'_c$ | ------- | 60 | 75 | 90 |
| Shear: v (as a measure of diagonal tension) | | | | | | |
| Beams with no web reinforcement | $v_c$ | $0.03f'_c$ | ------- | 60 | 75 | 90 |
| Beams with properly designed web reinforcement | v | $0.12f'_c$ | ------- | 240 | 300 | 360 |
| Flat slabs at distance d from edge of column capital or drop panel | $v_c$ | $0.03f'_c$ | ------- | 60 | 75 | 90 |
| Footings | $v_c$ | $0.03f'_c$ | 75 | 60 | 75 | 75 |
| Bond: u | | | | | | |
| Deformed bars | | | | | | |
| Top bars | ------ | $0.07f'_c$ | 245 | 140 | 175 | 210 |
| In 2-way footings (except top bars) | ------ | $0.08f'_c$ | 280 | 160 | 200 | 240 |
| All others | ------ | $0.10f'_c$ | 350 | 200 | 250 | 300 |
| Plain bars (must be hooked) | | | | | | |
| Top bars | ------ | $0.03f'_c$ | 105 | 60 | 75 | 90 |
| In 2-way footings (except top bars) | ------ | $0.036f'_c$ | 126 | 72 | 90 | 108 |
| All others | ------ | $0.045f'_c$ | 158 | 90 | 113 | 135 |
| Bearing: $f_c$ | | | | | | |
| Walls, Piers, Pilasters and Pedestals | | | | | | |
| On full area | $f_c$ | $0.25f'_c$ | ------- | 500 | 625 | 750 |
| On ⅓ area or less | $f_c$ | $0.375f'_c$ | ------- | 750 | 938 | 1125 |
| Columns: See section Ind 53.19 | | | | | | |

(4) ALLOWABLE UNIT STRESSES IN REINFORCEMENT. (a) *Tension in longitudinal steel and web reinforcement:*

1. Structural grade steel rods ---------- $f_s = 18,000$
2. Intermediate grade and hard steel rods (Billet steel, rail steel or axle steel) ---------- $f_s = 20,000$

(b) *Compression in column verticals:*

1. Intermediate grade steel rods ---------- $f_s = 16,000$
2. Hard grade steel rods (Billet steel, rail steel or axle steel) ---------- $f_s = 20,000$
3. The symbols and notation used in the above formulas are defined as follows:

$f'_c$—ultimate compressive strength of concrete at age of 28 days.

$f_c$—compressive unit stress in extreme fibre of concrete in flexure or axial compression in concrete in columns.

$v_c$—unit shearing stress in concrete.

u —bond stress per unit area of surface of bar.

$f_s$—tensile unit stress in reinforcement.

(5) ULTIMATE STRENGTH METHOD OF DESIGN. (a) The ultimate strength method of design for reinforced concrete may be used under the following conditions if approved in writing by the industrial commission.

1. Where the ultimate strength method of design is used, all other features of the design shall conform to the requirements of the building code.

2. Positive control shall be provided for the concrete mix. This includes periodic tests of regular concrete cylinders to determine the strength of the concrete.

3. Supervision shall be provided by the supervising architect or engineer during mixing and pouring operations where this method of design is involved.

**History:** 1-2-56; cr. (5), Register, September, 1959, No. 45, eff. 10-1-59.

**Ind 53.23 Reinforced gypsum concrete.** (1) MATERIALS. (a) The term "gypsum" as used in this chapter shall mean calcined gypsum manufactured from gypsum meeting the requirements of the American Society for Testing Materials' Standard Specifications for Gypsum C22-25, (American Standard A49.1-1933).

(b) Gypsum concrete shall consist of a mixture of gypsum and water, with or without wood chips, fiber or other approved aggregate.

(c) Precast gypsum concrete shall contain not more than 3% and cast-in-place gypsum concrete not more than 12½% of wood chips, shavings, or fiber measured as a percentage by weight of the dry mix.

(d) Wood chips, shavings, or fiber used in gypsum concrete shall be dry, soft wood, uniform and clean in appearance. They shall pass a 1-inch screen and shall be not more than ⅛ inch in thickness.

(e) Steel bar and wire reinforcing shall meet the requirements of Wis. Adm. Code subsection Ind 53.14 (5).

(2) MINIMUM THICKNESS. (a) The minimum thickness of gypsum concrete in floors and roofs shall be 2 inches except the suspension system, which shall be not less than 3 inches thick. Hollow precast gypsum concrete units for roof construction shall be not less than 3 inches thick and the shell not less than ½ inch thick.

(b) Precast gypsum concrete units for floor and roof construction shall be reinforced and unless the shape or marking of the unit is such as to insure its being placed right side up, the reinforcing shall be symmetrical so that the unit can support its load either side up.

(3) DESIGN. (a) Reinforced gypsum concrete shall be designed by methods admitting of rational analysis according to established principles of mechanics, to support the loads and withstand the forces to which it is subject without exceeding the stresses allowed in this chapter for the materials thereof except as hereinafter provided. The general assumptions and principles established for reinforced concrete shall also apply to reinforced gypsum concrete insofar as they are pertinent.

(b) For precast gypsum structural units which can not be analyzed in accordance with established principles of mechanics, the safe uniformly distributed carrying capacity shall be taken as ⅙ of the

total load causing failure in a full size test panel with the load applied along 2 lines each distant ¼ of the clear span from the support.

(c) Reinforced gypsum concrete shall not be used where exposed directly to the weather or where subjected to frequent or continuous wetting.

(4) STRENGTH. (a) Gypsum concrete shall be classified according to mixture, and concrete of each class shall have a minimum strength in compression as follows:

| | | |
|---|---|---|
| 1. Class 1 | Neat (Containing gypsum and water only) | 1800 lbs. per sq. in. |
| 2. Class 2 | Containing not more than 3% by weight of wood chips or fiber | 1000 lbs. per sq. in. |
| 3. Class 3 | Containing not more than 12½% by weight of wood chips or fiber | 500 lbs. per sq. in. |

(b) The strength of gypsum concrete shall be determined by compressive tests of 5 cylinders, 6 inches in diameter and 12 inches in length, from each 25 tons or fraction thereof. The test specimens shall be dried at a temperature of not less than 70 degrees Fahrenheit nor more than 100 degrees Fahrenheit in an atmosphere of not more than 50% relative humidity. The specimens shall be weighed at 1-day intervals until constant weight is attained. The method of testing and application of load shall be in accordance with the requirements specified in sections 19 and 20 of Standard Methods of Making Compression Tests of Concrete, A.S.T.M. C39–39. The average of the 5 specimens shall not fall below the specified minimum and in no case shall any specimen show a strength of less than 80% of the specified minimum.

(5) MODULUS OF ELASTICITY. (a) In the design of structural members of reinforced gypsum concrete the following values shall be used for the modulus of elasticity:

| | | |
|---|---|---|
| 1. Class 1 | Neat | 1,000,000 lbs. per sq. in. |
| 2. Class 2 | Containing not more than 3% by weight of wood chips or fiber | 600,000 lbs. per sq. in. |
| 3. Class 3 | Containing not more than 12½% by weight of wood chips or fiber | 200,000 lbs. per sq. in. |

(6) ALLOWABLE STRESSES. (a) In the design of structural members of reinforced gypsum concrete the stresses in the concrete shall not exceed the following allowable values:

| | |
|---|---|
| 1. Compressive stress in bending | $0.25f_c$ |
| 2. Axial compressive or bearing stress | $0.20f_c$ |
| 3. Bond stress (reinforcement anchored) | $0.02f_c$ |
| 4. Shearing stress (reinforcement anchored) | $0.02f_c$ |

5. In this table ($f_c$) indicates the compressive strength of the gypsum concrete as specified in subsection (4) (a).

(b) The tensile stresses in reinforcing steel shall be as specified for reinforced concrete made with Portland cement.

(7) SUSPENSION SYSTEM. In the construction of floors or other slabs the reinforcing shall consist of wires with continuity through multiple spans and anchored at the ends. The wires shall be supported in the top of the slab by the roof or floor beams and shall be tightly drawn down as nearly to the bottom of the slab at midspan as fire protection requirements will allow. Provision shall be made in the framing of the end bays of this system for resisting the forces due to end anchorage of the wires. The wires shall be designed for a tension in pounds per foot width of slab equal to:

$$\frac{wL^2}{8d}$$

in which

$w$ is the total load in lbs. per sq. ft.
$L$ is the clear span in feet
$d$ is the sag of the wires in feet

**Ind 53.24 Structural steel.** (1) MATERIAL. (a) *Minimum yield point.* The minimum yield point in pounds per square inch for structural steel used in buildings and structures under this code shall be as follows:

| | |
|---|---|
| Steel for bridges and buildings, Designation A-7 | 33,000 |
| Structural steel for welding, Designation A-373 | 32,000 |
| Structural steel, Designation A-36 | 36,000 |
| High-strength structural steel, Designation A-440 | 42,000—50,000 |
| High-strength low-alloy structural manganese vanadium steel, Designation A-441 | 42,000—50,000 |
| High-strength low-alloy structural steel, Designation A-242 | 42,000—50,000 |

1. Certified test reports shall be submitted as evidence of conformity with the specifications when requested by the industrial commission.

2. Unidentified steel, if free from surface imperfections, may be used for parts of minor importance, or for unimportant details, where the precise physical properties of the steel and its weldability would not affect the strength of the structure.

(b) *Other metals.* Cast steel shall conform to one of the following specifications:

Mild-to-medium-strength carbon-steel castings for general application, Designation A-27, Grade 65-35.

High-strength steel castings for structural purposes, Designation A-148, Grade 80-50.

1. Certified test reports shall be submitted as evidence of conformity with the specifications when requested by the industrial commission.

2. Steel forgings shall conform to one of the following specifications:

a. Carbon steel forgings for general industrial use, Designation A-235, Class C1, F and G. (Class C1 forgings that are to be welded shall be ordered in accordance with supplemental requirements S5 of A-235.)

b. Alloy steel forgings for general industrial use, Designation A-237, Class A.

3. Certified test reports shall be submitted as evidence of conformity with the specifications when requested by the industrial commission.

(c) *Rivet steel.* Rivet steel shall conform to one of the following specifications:

Structural rivet steel, Designation A–141.
High-strength structural rivet steel, Designation A–195.
High-strength structural alloy rivet steel, Designation A–406.

1. Certified test reports shall be submitted as evidence of conformity with the specifications when requested by the industrial commission.

(d) *Bolts.* High-strength steel bolts shall conform to one of the following specifications:

High-strength steel bolts for structural joints, Designation A-325.

Quenched and tempered alloy steel bolts and studs with suitable nuts, Designation A-354, Grade BC.

1. Other bolts shall conform to the specification for low-carbon steel externally and internally threaded standard fasteners, Designation A-307, hereinafter designated as A-307 bolts.

2. Manufacturer's certification shall be submitted as evidence of conformity with the specifications when requested by the industrial commission.

(e) *Filler metal for welding.* Welding electrodes for manual shielded metal arc welding shall conform to the E60 or E70 series of the specification for mild steel arc welding electrodes, Designation A-233.

1. Bare electrodes and granular fusible flux used in combinations for submerged arc welding shall be capable of producing weld metal having the following tensile properties when deposited in a multiple pass weld:

| | |
|---|---|
| a. Grade SA-1 | |
| Tensile strength | 62,000 to 80,000 psi |
| Yield point, min. | 45,000 psi |
| Elongation in 2 in., min. | 25% |
| Reduction in area, min. | 40% |
| b. Grade SA-2 | |
| Tensile strength | 70,000 to 90,000 psi |
| Yield point, min. | 50,000 psi |
| Elongation in 2 in., min. | 22% |
| Reduction in area, min. | 40% |

2. Manufacturer's certification shall be submitted as evidence of conformity with the specifications when requested by the industrial commission.

(2) ALLOWABLE UNIT STRESSES. All components of the structure shall be so proportioned that the unit stresses in pounds per square inch shall not exceed the following values except as specified in Wis. Adm. Code section Ind 53.01.

(a) *Structural steel.* 1. Tension. a. On the net section, except as pin holes

$$F_t = 0.60F_y$$

b. On the net section at pin holes in eyebars, pin-connected plates or built-up members

$$F_t = 0.45\ F_y$$

*Note:* $F_t$ = Allowable tensile stress
$F_y$ = Minimum yield point of type of steel used

2. Shear. On the gross section of beam and plate girder webs

$$F_v = 0.40 F_y$$

3. Compression. a. On the gross section of axially loaded compression members when $\frac{l}{r}$, the largest slenderness ratio of any unbraced segment is less than $C_c$

(FORMULA 1)

$$F_a = \frac{\left[1 - \frac{\left(\frac{l}{r}\right)^2}{2C_c^2}\right] F_y}{F.\ S.}$$

Where

$$F.\ S. = \text{factor of safety} = \frac{5}{3} + \frac{3\left(\frac{l}{r}\right)}{8C_c} - \frac{\left(\frac{l}{r}\right)^3}{8C_c^3}$$

and

$$C_c = \sqrt{\frac{2\pi^2 E}{F_y}}$$

b. On the gross section of axially loaded columns when $\frac{l}{r}$ exceeds $C_c$

(FORMULA 2)

$$F_a = \frac{149{,}000{,}000}{\left(\frac{l}{r}\right)^2}$$

c. On the gross section of axially loaded bracing and secondary members, when $\frac{l}{r}$ exceeds 120

(FORMULA 3)

$$F_a = \frac{F_a \text{ (by Formula 1 or 2)}}{1.6 - \frac{l}{200r}}$$

d. On the gross area of plate girder stiffeners

$$F_a = 0.60\ F_y$$

e. On the web of rolled shapes at the toe of the fillet.

$$F_a = 0.75\ F_y$$

4. Bending. a. Tension and compression on extreme fibers of rolled shapes and built-up members having an axis of symmetry in the plane

of loading and proportions meeting the requirements of compact sections, when the member is supported laterally at intervals no greater than 13 times its compression flange width

$$F_b = 0.66\ F_y$$

b. Beams and girders which meet the requirements of the preceding paragraph and are continuous over supports or are rigidly framed to columns by means of rivets, high-strength bolts or welds, may be proportioned for 9/10 of the negative moments produced by gravity loading which are maximum at points of support provided that, for such members, the maximum positive moment shall be increased by 1/10 of the average negative moments. This reduction shall not apply to moments produced by loading on cantilevers. If the negative moment is resisted by a column rigidly framed to the beam or girder, the 1/10 reduction may be used in proportioning the column for the combined axial and bending loading, provided that the unit stress, due to any concurrent axial load on the member, does not exceed $0.15F_y$.

c. Tension and compression on extreme fibers of unsymmetrical members supported in the region of compression stress as specified in section 4. a.

$$F_b = 0.60F_y$$

d. Tension and compression on extreme fibers of box-type members whose proportions do not meet the provisions of compact sections, but do conform to the provisions of section 5—Width-Thickness Ratio.

$$F_b = 0.60F_y$$

e. Tension on extreme fibers of other rolled shapes, built-up members, and plate girders.

$$F_b = 0.60F_y$$

f. Compression on extreme fibers of rolled shapes, plate girders, and built-up members having an axis of symmetry in the plane of their web (other than box-type beams and girders), the larger value computed by formulas (4) and (5), but not more than $0.60F_y$

(FORMULA 4)

$$F_b = \left[1.0 - \frac{\left(\frac{l}{r}\right)^2}{2C_c^2 C_b}\right] 0.60F_y$$

(FORMULA 5)

$$F_b = \frac{12{,}000{,}000}{\frac{ld}{A_f}}$$

where l is the unbraced length of the compression flange; r is the radius of gyration of a tee section comprising the compression flange plus 1/6 of the web area, about an axis in the plane of the web; $A_f$ is the area of the compression flange; $C_c$ is defined in section 3. a. and $C_b$, which can conservatively be taken as unity, is equal to

$$C_b = 1.75 - 1.05\left(\frac{M_1}{M_2}\right) + 0.3\left(\frac{M_1}{M_2}\right)^2, \text{ but not more than } 2.3$$

where $M_1$ is the smaller and $M_2$ the larger bending moment at the ends of the unbraced length, taken about the strong axis of the member, and where $\frac{M_1}{M_2}$, the ratio of end moments, is positive when $M_1$ and $M_2$ have the same sign (single curvature bending) and negative when they are of opposite signs (reverse curvature bending). When the bending moment at any point within an unbraced length is larger than that at both ends of this length the ratio $\frac{M_1}{M_2}$ shall be taken as unity.

g. Compression on extreme fibers of channels, the value computed by formula (5), but not more than

$$F_b = 0.60F_y$$

h. Tension and compression on extreme fibers of large pins.

$$F_b = 0.90F_y$$

i. Tension and compression on extreme fibers of rectangular bearing plates.

$$F_b = 0.75F_y$$

5. Bearing (on contact area). a. Milled surfaces and pins in reamed, drilled or bored holes, pounds per square inch

b. Finished stiffeners pounds per square inch

$$F_p = 0.80\ F_y$$

$$F_p = 0.90F_y$$

c. Expansion rollers and rockers, pounds per linear inch

$$F_p = \left(\frac{F_y - 13{,}000}{20{,}000}\right) 660d$$

where d is the diameter of roller rocker in inches

d. Rivets and bolts. Allowable unit tension and shear stresses on rivets, bolts and threaded parts (pounds per square inch of area of rivets before driving or unthreaded body area of bolts and threaded parts) shall be as given in table 1.

**TABLE 1**

| Description of Fastener | Tension ($F_t$) | Shear ($F_v$) | |
|---|---|---|---|
| | | Friction-type Connections | Bearing-type Connections |
| A141 hot-driven rivets | 20,000 | ---------- | 15,000 |
| A195 and A406 hot-driven rivets | 27,000 | ---------- | 20,000 |
| A307 bolts and threaded parts of A7 and A373 steel | 14,000 | ---------- | 10,000 |
| Threaded parts of other steels | $0.40F_y$ | ---------- | $0.30F_y$ |
| A325 bolts when threading is *not* excluded from shear planes | 40,000 | 15,000 | 15,000 |
| A325 bolts when threading is excluded from shear planes | 40,000 | 15,000 | 22,000 |
| A354, Grade BC, bolts when threading is *not* excluded from shear planes | 50,000 | 20,000 | 20,000 |
| A354, Grade BC, when threading is excluded from shear planes | 50,000 | 20,000 | 24,000 |

Allowable bearing stress on projected area of bolts in bearing-type connections and on rivets.

$$F_p = 1.35F_y$$

(Bearing stress not restricted in friction-type connections assembled with A325 and A354, Grade BC, bolts).

Welds (stress in pounds per square inch throat area).

Fillet, plug, slot and partial penetration groove welds.

Fillet, plug, slot and partial penetration groove welds made with A233 Class E60 series electrodes and fillet welds made by submerged arc welding Grade SA–1—13,600.

Fillet, plug, slot and partial penetration groove welds made with A233 Class E70 series electrodes and fillet welds made by submerged arc welding Grade SA–2—15,800.

Complete penetration groove welds.

On complete penetration groove welds the allowable tension, compression, bending, shear and bearing stresses shall be the same as those allowed by section (2) in the connected material.

e. Cast steel and steel forgings.

1. Tension (on net section) $F_t$ $0.60F_y$
2. Shear (on gross section) $F_v$ $0.40F_y$
3. Compression—same as provided under section (2) (a) 3. a.
4. Bending (on extreme fibers) $F_b$ $0.60F_y$
5. Bearing—same as provided under section (2) (a) 5.

f. Wind stresses. (See Wis. Adm. Code section Ind 53.01)

(3) COMBINED STRESSES. (a) *Axial compression and bending.* Members subject to both axial compression and bending stresses shall be proportioned to meet the requirements of both Formula (6) and Formula (7).

FORMULA (6)

$$\frac{f_a}{F_a} + \frac{C_m f_b}{\left(1 - \frac{f_a}{F'_e}\right) F_b} \leq 1.0$$

FORMULA (7)

$$\frac{f_a}{0.6F_y} + \frac{f_b}{F_b} \leq 1.0 \text{ (applicable only at braced points)}$$

where

$F_a$ = axial stress that would be permitted if axial stress alone existed

$F_b$ = bending stress that would be permitted if bending stress alone existed

$F'_e = \frac{149{,}000{,}000}{\left(\frac{l}{r_b}\right)^2}$ (May be increased ⅓ in accordance with Wis. Adm. Code section Ind 53.01)

$l$ = actual unbraced length in the plane of bending

$r_b$ = radius of gyration about axis of bending

$f_a$ = computed axial stress

$f_b$ = computed bending stress at the point under consideration
$C_m$ = 0.85, except as follows:

1. When $\frac{f_a}{F_a} \leq 0.15$. (For this case the member selected shall meet the limitation that
$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1.0$$
2. For restrained compression members in frames braced against joint translation but not subject to transverse loading between their supports in the plane of loading, $C_m$ may be taken as 0.6 plus 0.4 $\left(\frac{M_1}{M_2}\right)$, where $\frac{M_1}{M_2}$ is the ratio of smaller to larger moments at the ends of the critical unbraced length of the member. $\frac{M_1}{M_2}$ is positive when the unbraced length is bent in single curvature and negative when it is bent in reverse curvature.
3. For restrained compression members in frames braced against joint translation in the plane of loading and subject to transverse loading between their supports (joints) in the plane of loading, a value of $C_m$ may be determined by rational analysis.

(b) *Shear and tension.* Rivets and bolts subject to combined shear and tension due to force applied to the connected parts, shall be so proportioned that the tension stress produced by the force shall not exceed the following:

For A141 rivets ---------- $F_t = 28{,}000 - 1.6f_v \leq 20{,}000$
For A195 and A406 rivets ---------- $F_t = 38{,}000 - 1.6f_v \leq 27{,}000$
For A307 bolts ---------- $F_t = 20{,}000 - 1.6f_v \leq 14{,}000$
For A325 bolts in bearing-type joints ---------- $F_t = 50{,}000 - 1.6f_v \leq 40{,}000$
For A354, Grade BC, bolts in bearing-type joints ---------- $F_t = 60{,}000 - 1.6f_v \leq 50{,}000$

where $f_v$, the shear stress produced by the same force, shall not exceed the value for shear given in section (2) 5. (d).

For bolts used in friction-type joints, the shear stress allowed in section (2) 5. (d) shall be reduced as follows:

For A 325 bolts ---------- $F_v \leq 15{,}000 \left(1 - \frac{f_t A_b}{T_b}\right)$

For A 354, Grade BC, bolts ---------- $F_v \leq 20{,}000 \left(1 - \frac{f_t A_b}{T_b}\right)$

where $f_t$ is the tensile stress due to applied load and $T_b$ is the proof load of the bolt.

(4) SLENDERNESS RATIOS. (a) *Definition.* In determining the slenderness ratio of an axially loaded compression member, l shall be taken as its effective length and r the corresponding radius of gyration.

(b) *Sidesway prevented.* The effective length of compression members in trusses, and in frames where lateral stability is provided by diagonal bracing, shear walls, attachment to an adjacent structure having adequate lateral stability, or by floor slabs or roof decks secured horizontally by walls or bracing systems parallel to the plane of the frame, shall be taken as the actual unbraced length, unless analysis shows that a shorter length may be used.

(c) *Sidesway not prevented.* The effective length of compression members in a frame which depends upon its own bending stiffness for lateral stability, shall be determined by a rational method and shall not be less than the actual unbraced length.

(d) *Maximum ratios.* The slenderness ratio of compression members shall not exceed 200. The slenderness ratio of tension members, other than rods, preferably should not exceed:

For main members ..... 240
For bracing and other secondary members ..... 300

(5) WIDTH-THICKNESS RATIOS. (a) *Projecting elements under compression.* 1. Projecting elements of members subjected to axial compression or compression due to bending shall have ratios of width-to-thickness not greater than the following:

Single-angle struts; double-angle struts with separators .... $\frac{2,400}{\sqrt{F_y}}$

Struts comprising double angles in contact; angles or plates projecting from girders, columns or other compression members; compression flanges of beams; stiffeners on plate girders $\frac{3,000}{\sqrt{F_y}}$

Stems of tees ..... $\frac{4,000}{\sqrt{F_y}}$

2. The width of plates shall be taken from the free edge to the first row of rivets, bolts, or welds; the width of legs of angles, channels and zees, and of the stems of tees, shall be taken as the full nominal dimension; the width of flanges of beams and tees shall be taken as ½ the full nominal width. The thickness of a sloping flange shall be measured halfway between a free edge and the corresponding face of the web.

3. When a projecting element exceeds the width-to-thickness ratio prescribed in the preceding paragraph, but would conform to same and would satisfy the stress requirements with a portion of its width considered as removed, the member will be acceptable.

(b) *Compression elements supported along 2 edges.* 1. In compression members the unsupported width of web, cover or diaphragm plates, between the nearest lines of fasteners or welds, or between the roots of the flanges in case of rolled sections, shall not exceed $\frac{8,000}{\sqrt{F_y}}$ times its thickness.

2. When the unsupported width exceeds this limit, but a portion of its width no greater than $\frac{8,000}{\sqrt{F_y}}$ times the thickness would satisfy the stress requirements, the member will be considered acceptable.

3. The unsupported width of cover plates perforated with a succession of access holes, may exceed $\frac{8,000}{\sqrt{F_y}}$, but shall not exceed $\frac{10,000}{\sqrt{F_y}}$, times the thickness. The gross width of the plate less the width of the widest access hole shall be assumed available to resist compression.

(6) SIMPLE AND CONTINUOUS SPANS. (a) *Simple spans.* Beams, girders and trusses shall ordinarily be designed on the basis of simple spans whose effective length is equal to the distance between centers of gravity of the members to which they deliver their end reactions.

(b) *End restraint.* When designed on the assumption of full or partial end restraint, due to continuous, semi-continuous or cantilever action, the beams, girders and trusses, as well as the sections of the members to which they connect, shall be designed to carry the shears and moments so introduced, as well as all other forces, without exceeding at any point the unit stresses prescribed in section (2) (a); except that some non-elastic but self-limiting deformation of a part of the connection may be permitted when this is essential to the avoidance of overstressing of fasteners.

(7) DEFLECTIONS. (a) Beams and girders supporting floors and roofs shall be proportioned with due regard to the deflection produced by the design loads.

(b) Beams and girders supporting plastered ceilings shall be so proportioned that the maximum live load deflection will not exceed 1/360 of the span.

(c) The depth of beams and girders supporting flat roofs shall be not less than $\frac{F_y}{1,000,000}$ times their span length whether designed as simple or continuous spans.

(8) CONNECTIONS. (a) *Minimum connections.* Connections carrying calculated stresses, except for lacing, sag bars, and girts, shall be designed to support not less than 6,000 pounds.

(b) *Eccentric connections.* Axially stressed members meeting at a point shall have their gravity axes intersect at a point if practicable; if not, provision shall be made for bending stresses due to the eccentricity.

(c) *Placement of rivets, bolts and welds.* Except as hereinafter provided, the rivets, bolts or welds at the ends of any member transmitting axial stress into that member shall have their centers of gravity on the gravity axis of the member unless provision is made for the effect of the resulting eccentricity. Except in members subject to repeated variation in stress, disposition of fillet welds to balance the forces about the neutral axis or axes for end connections of single angle, double angle, and similar type members is not required. Eccentricity between the gravity axes of such members and the gauge lines for their riveted or bolted end connections may be neglected.

(d) *Unrestrained members.* Except as otherwise indicated by the designer, connections of beams, girders or trusses shall be designed as flexible, and may ordinarily be proportioned for the reaction shears only. Flexible beam connections shall permit the ends of the beam to rotate sufficiently to accommodate its deflection by providing for a horizontal displacement of the top flange determined as follows:

$e = 0.007d$, when the beam is designed for full uniform load and for live load deflection not exceeding 1/360 of the span

$= \frac{f_b L}{3{,}600{,}000}$, when the beam is designed for full uniform load producing the unit stress $f_b$ at mid-span

where

$e$ = the horizontal displacement of the end of the top flange, in the direction of the span, in inches

$f_b$ = the flexural unit stress in the beam at mid-span, in pounds per square inch

$d$ = the depth of the beam, in inches

$L$ = the span of the beam, in feet

(e) *Restrained members.* Fasteners or welds for end connections of beams, girders and trusses not conforming to the requirements of section (8) (d) shall be designed for the combined effect of end reaction shear and tensile or compressive stresses resulting from moment induced by the rigidity of the connection when the member is fully loaded.

(9) COLUMN BASES. (a) *Loads.* Proper provision shall be made to transfer the column loads and moments, if any, to the footings and foundations.

(b) *Alignment.* Column bases shall be set level and to correct elevation with full bearing on the masonry.

(c) *Finishing.* Column bases shall be finished in accordance with the following requirements:

1. Rolled steel bearing plates, 2 inches or less in thickness, may be used without planing, provided a satisfactory contact bearing is obtained; rolled steel bearing plates over 2 inches but not over 4 inches in thickness may be straightened by pressing; or, if presses are not available, by planing for all bearing surfaces (except as noted under requirement 3. of this section), to obtain a satisfactory contact bearing; rolled steel bearing plates over 4 inches in thickness shall be planed for all bearing surfaces (except as noted under requirement 3. of this section).

2. Column bases other than rolled steel bearing plates shall be planed for all bearing surfaces (except as noted under requirement 3. of this section).

3. The bottom surfaces of bearing plates and column bases which are grouted to insure full bearing contact on foundations need not be planed.

(10) SHOP PAINTING. (a) *General requirements.* Unless otherwise specified, steelwork which will be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned in accordance with the following paragraph, by brush, spray, roller coating, flow coating, or dipping, at the election of the fabricator.

(b) *Cleaning.* After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by handwire brushing, or by other methods elected by the fabricator, of loose

mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint, after fabrication, shall be cleaned of oil or grease by solvent cleaners and shall be cleaned of dirt and other foreign material by thorough sweeping with a fiber brush.

(c) *Protection for short period of exposure.* The shop coat of paint is intended to protect the steel for only a short period of exposure, even if it is a primer for subsequent painting to be performed in the field by others.

(d) *Inaccessible surfaces.* Surfaces inaccessible after assembly shall be treated in accordance with section (10) (a) before assembly.

(e) *Contact surfaces.* Contact surfaces shall be cleaned in accordance with section (10) (a) before assembly but shall not be painted.

(f) *Finished surfaces.* Machine finished surfaces shall be protected against corrosion by a rust-inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

(g) *Surfaces adjacent to field welds.* Unless otherwise provided, surfaces within 2 inches of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

(11) ERECTION. (a) *Bracing.* The frame of steel skeleton buildings shall be carried up true and plumb, and temporary bracing shall be introduced whenever necessary to take care of all loads to which the structure may be subjected, including equipment and the operation of same. Such bracing shall be left in place as long as may be required for safety.

(b) *Carrying.* Wherever piles of material, erection equipment or other loads are carried during erection, proper provision shall be made to take care of stresses resulting from such loads.

(c) *Adequacy of temporary connections.* As erection progresses, the work shall be securely bolted, or welded, to take care of all dead load, wind and erection stresses.

(d) *Alignment.* No riveting, permanent bolting or welding shall be done until as much of the structure as will be stiffened thereby has been properly aligned.

(e) *Field welding.* Any shop paint on surfaces adjacent to joints to be field welded shall be wire brushed to reduce the paint film to a minimum.

(f) *Field painting.* Responsibility for touch-up painting and cleaning, as well as for general painting shall be allocated in accordance with accepted local practices and this allocation shall be set forth explicitly in the contract.

(12) PLASTIC DESIGN AND FABRICATION. (a) The design, fabrication and erection of structural steel for buildings and structures by the plastic design method shall conform with recognized good engineering practice as approved by the industrial commission.

*Note:* It will be the policy of the industrial commission to accept methods of plastic design which conform with the rules for plastic design and fabrication of structural steel issued by the American Institute of Steel Construction.

(13) WELDS. (a) *Type of welds.* Butt, fillet, plug or slot welds, or a combination of these types, may be used in making joints and joining component parts.

(b) *Qualification of weld details.* The details of all joints (including for butt welds, the groove form, root face, root spacing, etc.) to be employed under this rule without qualification shall comply with all of the requirements for joints which are accepted without qualification test by the industrial commission. No joint form not included in the foregoing shall be employed until it shall have been qualified to the satisfaction of the industrial commission.

*Note:* It will be the policy of the industrial commission to approve of weld details, processes and methods conforming to the requirements of the standard code for arc and gas welding in building construction of the American Welding Society.

(c) *Operator qualifications.* All welding shall be done by skilled workmen who shall give satisfactory proof of their skill and ability with process to be used on the proposed work.

(d) *Qualifications and inspection requirements for welding operations and operators.* 1. The state building code provides that the industrial commission shall determine necessary data, tests and other evidence required to prove the merits of materials, methods of construction and devices used in the construction, alteration and equipment of buildings or structures, and further, in connection with welding, requires such work to be done by skilled welders who must give satisfactory proof of their skill and ability.

2. In conformance with these provisions, the following regulations are adopted and promulgated to apply to all welding operations on buildings and structures coming within the scope of the state building code.

3. All welding operators employed as such in executive work covered by the Wisconsin state building code shall be previously qualified by tests as prescribed herein. These qualification tests shall be performed under the supervision of an approved testing laboratory or commercial testing engineer who will certify to the industrial commission that the operator has passed the prescribed qualification tests.

4. The industrial commission shall issue, to any operator who has successfully passed the prescribed qualification tests, a certificate bearing the operator's name, address and signature, and the record of the extent of his successful qualification testing. This certificate shall remain in force for one year provided the operator is engaged in welding without an interruption of more than 3 consecutive months' duration, in which latter case the certificate shall automatically become void. The renewal of a certificate shall be granted only upon successful completion of new qualification tests.

5. The procedure for qualification of welding operators shall consist essentially of tests for the making of both groove and fillet welds in 4 positions each. One test is required for each position for fillet welds, and for groove welds one test for each position in material up to and including ¾ inch thick shall be made in material ¾ inch thick, except that if the construction involves welding of material over ¾ inch thick, one test weld shall be made for each position in material of the maximum thickness to be used, but need not exceed one inch in thickness, if a test weld is made in the maximum or one inch thickness, no test weld is necessary in the ⅜ inch thickness.

6. All welding shall be subject to examination by a competent inspector approved by the industrial commission, who shall certify to the industrial commission that all welding has been completed in accordance with the approved plans and specifications and with the provisions of the Wisconsin state building code.

*Note:* The methods and procedures of such inspection shall be in accordance with the provisions of section 5 of the Code for Arc and Gas Welding in Building Construction, latest edition, as published by the American Welding Society.

7. The form SB–13A "Certificate of Competency—WELDER" is issued pursuant to Wis. Adm. Code Ind 53.24 (13) (c).

*Note:* Section Ind 53.24 is based on the American Institute of Steel Specification dated November 30, 1961. For members and connections subject to repeated variation of stress, plate girders, composite construction, fabrication, shop practice, and plastic design, see A.I.S.C. Specification.

(14) LIGHT GAUGE STEEL STRUCTURAL MEMBERS. (a) *Scope.* The requirements of this section shall apply to the design of structural members formed of sheet or strip steel less than 3/16 inch thick and used for load carrying purposes in buildings and structures within the scope of this code. All such structural members shall be capable of supporting all required loads without exceeding the allowable unit stresses specified in this section and shall be designed in accordance with recognized engineering practice.

(b) *Material.* 1. All steel used in the construction of buildings and structures shall be fabricated from materials of uniform quality and free from defects that would impair the strength or stability of the structure.

*Note:* It will be the policy of the industrial commission to approve, subject to the provisions of this section, steel that conforms to the following standard specifications of the American Society for Testing Materials:

a. Flat-rolled carbon steel sheets of structural quality. Designation A245
b. Hot rolled carbon strip of structural quality. Designation A303
c. High-strength low-alloy cold rolled steel sheets and strip. Designation A374
d. High-strength low-alloy hot rolled steel sheets and strip. Designation A375

2. Steel of higher strength than is covered by the above mentioned specifications may be used at the unit stresses herein specified for "other grades" of steel provided the design is based upon the minimum properties of those grades of steel as guaranteed by the manufacturer. When requested by the industrial commission, the manufacturer shall furnish certified data showing the properties of such grades of steel.

(c) *Basic design stress. Allowable working stresses.* 1. Tension on the net section of tension members, and tension and compression $f_b$ on extreme fiber of flexural members shall not exceed the values specified in the following table, except as otherwise provided in this section:

| Grade of Steel | Minimum Yield Point Pounds per Sq. In. | Allowable Working Stress Pounds per Sq. In. |
|---|---|---|
| C | 33,000 | 20,000 |
| B | 30,000 | 18,000 |
| A | 25,000 | 15,000 |
| Other Grades | Minimum Yield Point Divided by 1.65 | |

2. Compression on unstiffened elements. Compression $f_c$ in pounds per square inch on flat unstiffened elements shall not exceed the values in accordance with the following formula:

a. For $\frac{w}{t}$ not greater than 10, $f_c = f_b$ except that when $f_b$ exceeds 30,000 psi, the maximum $\frac{w}{t}$ ratio for which $f_c$ may be taken equal to $f_c$ shall not exceed $\frac{300,000}{f_b}$

b. For $\frac{w}{t}$ greater than 10 but not greater than 25 $f_c = (1.667 f_b - 8640) - (1/15) \quad (f_b - 12950) \frac{w}{t}$

For steels with a yield point in excess of 50,000 psi, the value of $f_b$ to be used in the determination of $f_c$ when $\frac{w}{t}$ exceeds 10 shall be 30,000 psi.

c. For $\frac{w}{t}$ from 25 to 60

For angle struts $f_c = \frac{8,090,000}{\left(\frac{w}{t}\right)^2}$

For all other sections $f_c = 20,000 - 282\left(\frac{w}{t}\right)$

In the above formula $\frac{w}{t}$ = ratio of flat width to thickness of an element.

3. Allowable web shear. a. The maximum average web shear stress, v, in pounds per square inch on the gross area of a flat web shall not exceed the values in accordance with the following formula:

$$v = \frac{64,000,000}{\left(\frac{h}{t}\right)^2} \text{ with a maximum of } 2/3\ f_b.$$

In the above formula

$t$ = web thickness

$h$ = clear distance between flanges

$f_b$ = allowable working stress as specified in (c).

b. Where the web consists of 2 or more sheets, each sheet shall be considered as a separate member carrying its share of the shear.

c. Maximum slenderness ratio.

1. The maximum allowable ratio $\frac{L}{r}$ of unsupported length L to radius of gyration r, of compression members shall not exceed 200.

History: 1-2-56; cr. (9) (d) 7. Register, October, 1957, No. 22, eff. 11-1-57; cr. (15), Register, September, 1959, No. 45, eff. 10-1-59; am. Register, December, 1962, No. 84, eff. 1-1-63.

Ind 53.25 Steel joist construction. (1) DEFINITION. Steel joist construction shall consist of decks or top slabs defined in Wis. Adm. Code subsection Ind 53.25 (7), supported by separate steel members

referred to as steel joists. Any steel member suitable for supporting floors and roofs between the main supporting girders, trusses, beams, or walls when used as hereinafter stipulated shall be known as a "steel joist". Such steel joists may be made of hot or cold formed sections, strip or sheet steel, riveted or welded together, or by expanding.

(2) LIMIT OF SPAN AND SPACING. The clear span of steel joist shall not exceed 24 times the depth of the steel portion of the steel joist.

(a) The spacing of steel joist for floors shall not exceed the safe span for the top slab or flooring. Where the joist spacing for floors exceeds 24 inches on centers, the bridging shall be adequate to distribute concentrated loads between joist. The spacing of steel joist for roofs shall not exceed the safe span of the top slab or roof deck.

(b) Where these spans or spacings are exceeded, the requirements for steel joist construction shall not apply, but the steel members shall be designed in accordance with the requirements of Wis. Adm. Code section Ind 53.24.

(3) MATERIALS. All steel joist used in the construction of buildings and structures shall be fabricated from materials of uniform quality and free from defects that would impair the strength or stability of the structure. The steel used shall conform to the following specifications:

Structural steel for bridges and buildings: Designation A-7; Minimum yield point, 33,000
Structural steel: Designation A-36; Minimum yield point, 36,000
Flat rolled carbon steel sheets of structural quality: Designation A-245; Minimum yield point, 33,000
Hot rolled carbon steel strip of structural quality: Designation A-303; Minimum yield point, 33,000
High strength low alloy manganese, Vanadium steel; Designation A-441; Minimum yield point, 42,000—50,000
High strength structural steel: Designation A-440; Minimum yield point, 42,000—50,000

(a) All steel joist shall receive one coat of asphalt base paint or an equivalent protective covering before leaving the fabricating shop.

(4) DESIGN OF STEEL JOIST. An open web steel joist shall be built up of bars or other sections, or one fabricated by expanding a rolled section shall be designed as a truss. The compressive stress in chord members and diagnonals of the joist shall not exceed those given in Wis. Adm. Code section Ind 53.24 for main members. The tensile stress shall not exceed 0.60 of the yield point of the grade of steel used in any member. The minimum shear to be used in designing the web members shall not be less than 20% of the rated end reaction at midspan and shall be increased lineally to 30% of the rated end reaction at a distance 0.35 from the end supports.

(a) A solid web steel joist shall be designed as a beam in accordance with the requirements of Wis. Adm. Code section Ind 53.24.

(b) In the completed structure, the top chord of open web steel joist or the top flanges of solid web steel joist may be considered as being stayed laterally when the deck or top slab over the steel joist complies with the provisions of Wis. Adm. Code subsection Ind 53.25 (7).

(c) All joints and connections of an open web steel joist shall be capable of withstanding a load at least 3 times the designed load and shall be sufficiently rugged to resist the stresses incident to transportation and erection when handled in a reasonable manner.

(d) All elements of an open web joist shall have their lines of center of gravity meet at a point if practicable; if not, stresses arising from eccentricity shall be included with other stresses in designing these elements.

(e) Ends of steel joist shall be designed to resist the bending produced by the eccentricity of the reaction at the support.

(5) ERECTION. The ends of steel joist shall extend a distance of at least 4 inches on to masonry or reinforced concrete supports and at least 2½ inches on steel supports. In floor construction every third steel joist and in roof construction every steel joist supported on concrete or masonry supports shall be anchored thereto with an anchor equivalent to a ⅜ inch round bar. All steel joist supported on steel beams shall be secured thereto by welding or with an anchor made of not less than 3/16 inch bar fastened over the flanges of the supporting beams.

(a) The ends of long span steel joist shall extend a distance of not less than 6 inches on masonry or reinforced concrete supports and at least 4 inches on steel supports.

(b) During the construction period, care shall be exercised to prevent excessive concentrated or moving loads. The construction contractor shall provide for adequate distribution of such loads so that the carrying capacity of any steel joist is not exceeded during that period. When erected and bridged, the total concentrated load on any one steel joist shall not exceed 800 pounds and in the case of open web steel joist, such concentrated load shall not be imposed between panel points.

(6) BRIDGING. As soon as steel joist are erected, bridging shall be installed between the joist before the application of construction loads. This bridging shall be adequate to support the top chords or flanges against lateral movement during the construction period and shall hold the steel joist in a vertical plane passing through the bearings.

(a) Horizontal bridging shall consist of two continuous horizontal steel members, one of which is attached to the top chord and the other attached to the bottom chord. Attachment to the joist shall be made by welding or by mechanical means, and the attachments shall be capable of resisting a horizontal force of not less than 500 pounds.

The ratio of unbraced length to the least radius of gyration $\left(\frac{L}{r}\right)$ of the bridging member shall not exceed 300. Where a round bar is used for bridging the diameter shall be at least ½ inch.

(b) Diagonal cross bridging may be used for joist spacing up to 30 inches. The ratio of unbraced length to the least radius of gyration $\left(\frac{L}{r}\right)$ shall not exceed 200. Connections to the top and bottom chords of the joist shall be made by positive mechanical means or by welding.

(c) In roof construction, where the slope is perpendicular to the longitudinal axis of the joist, sag rods may be used in lieu of bridging. The rods shall not be less than ½ inch in diameter and the number of lines shall be the same as specified for bridging.

(d) In no case shall the spacing of bridging be greater than specified in the following table:

| *Clear Span* | *Number of Lines of Bridging* |
|---|---|
| Up to 14 feet | One row near center. |
| 14 to 21 feet | Two rows placed at 1/3 point of span. |
| 21 to 32 feet | Three rows placed at ¼ point of span. |
| 32 to 40 feet | Four rows placed at 1/5 point of span. |
| 40 to 48 feet | Five rows placed at 1/6 point of span. |

(e) Bridging for long span joist shall consist of cross bracing with an $\frac{L}{r}$ ratio of not more than 200. The maximum spacing of lines of bridging for long span joist shall not exceed the following:

| *Joist Depth in Inches* | *Maximum Spacing of Lines of Bridging* |
|---|---|
| 18 to 24 inches, inclusive | 10 feet |
| Over 24 to 36 inches, inclusive | 12 feet |
| Over 36 inches | 16 feet |

(7) DECKS AND TOP SLABS. Decks or top slabs over steel joist may be of concrete or gypsum poured on metal lath centering attached to the top chords or flanges of steel joist as required elsewhere in this section or on removable centering provided the top chords or flanges of the steel joist are properly stayed by the concrete or gypsum slab. Other equally suitable permanent centering may be used, provided it is substantially attached to the top chords or flanges as required elsewhere in this section and provided these attachments (or the centering itself) are securely anchored into the concrete or gypsum slab. Precast concrete or precast gypsum slabs when securely attached to the top chords or flanges and anchored thereto and brought to a firm bearing, wood decks as stipulated below, and corrugated or other steel roof decks securely anchored to the top chords or flanges may be used over steel joist. Any attachment or pair of attachments when applied shall be capable of staying the top chord or flange laterally in both directions and in the case of open web steel joist, shall be spaced not farther apart then the panel point spacing. Decks or top slabs over steel joist shall not be assumed to carry any part of the compression stress in the steel joist.

(a) Flat wood decks of single thickness of one inch nominal material shall not have a span of more than 20 inches for floors, or 30 inches for roofs. All such decks shall be securely fastened to the joist.

(b) Poured structural slabs of concrete, gypsum or other similar material shall not be less than 2 inches thick. They shall be poured upon ⅜ inch ribbed metal lath weighing not less than 4 pounds per square yard for spans not exceeding 24 inches and upon ¾ inch rib lath weighing not less than 4.5 pounds per square yard for spans not exceeding 30 inches. Other material equally suitable as a form or centering for casting concrete or gypsum slabs may be used in place of rib lath. Rib lath or other centering which remains in place shall be substantially attached to the top chord or flange of each steel joist at intervals of not over 8 inches. Such slabs shall be reinforced with mesh or rods, in addition to the rib lath, except that when slabs are to be covered with a wood strip top floor, the rib lath or centering may, if adequate, serve also as the reinforcement.

(c) Any material used as centering for the top slab shall be installed so as not to exert an undue lateral pull on the top chords or flanges of the steel joist.

History: 1-2-56; r. and recr., Register, September, 1959, No. 45, eff. 10-1-59; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 53.26 Wrought iron.** (1) The requirements for design, fabrication and erection of steel for buildings and structures under Wis. Adm. Code section Ind 53.24 shall apply to wrought iron, except that the following stresses in pounds per square inch shall not be exceeded:

(a) Tension on net section ..... 12,000

(b) Compression, on short lengths or where lateral deflection is prevented ..... 10,000
on gross section of columns

$$12{,}000 - 60\,\frac{L}{r}$$

in which $L$ = length in inches
$r$ = radius of gyration in inches

(c) Bending. On extreme fibers if lateral deflection is prevented ..... 12,000

(2) Wrought iron shall conform to the Standard Specifications for Refined Wrought Iron Plates, Serial Designation A42-18.

**Ind 53.27 Cast iron.** (1) The following unit stresses in pounds per square inch shall not be exceeded in cast iron:

(a) Tension on net section ..... 0

(b) Compression, on short lengths or where lateral deflection is prevented ..... 10,000
on gross section of columns

$$10{,}000 - 40\,\frac{L}{r}$$

in which $L$ = length in inches
$r$ = radius of gyration in inches

(c) Tension in the extreme fiber if lateral deflection is prevented ..... 3,000

(2) The material and workmanship of cast iron members shall be equal in all respects to that described in the American Society for Testing Materials Specifications for Gray-Iron Castings, Serial Designation A48-29.

(3) All columns resting on, or supporting, other columns shall have their ends machine faced to a plane surface perpendicular to the axis.

**Ind 53.28 Wood construction.** (1) Quality of material. The quality and design of all wood used in the construction of all buildings and structures or parts thereof, shall conform to the minimum standards under this section.

(a) All members shall be so framed, anchored, tied and braced together as to develop the maximum strength and rigidity necessary for the purpose for which they are used. No member shall be stressed in excess of the strength of its details and connections.

(b) All wood structural members shall be of sufficient quality, size and strength, as to carry their imposed loads safely and without exceeding the allowable working stresses as specified in this section.

(c) The requirements stated are a minimum standard and apply primarily to conventional types of construction.

(d) The substitution of materials other than those called for in the code will be permitted when shown by an approved authority to be equal to or better than those specified.

(e) Workmanship in fabrication, preparation, installation, joining of wood members and the connectors and mechanical devices for the fastening thereof, shall conform throughout to good engineering practice.

(f) Where wood is used in parts of a building or structure habitually exposed to moisture, ample ventilation or sufficient preservative treatment, or both, shall be provided.

(2) Allowable working stresses. In the design of wood structural members and the construction of structures of wood, the following unit stresses in pounds per square inch shall not be exceeded.

(a) Stresses that exceed those given in the following table for the lowest grade of any species shall be used only when the higher grade of that species is identified by the grade mark or a certificate of inspection issued by a recognized lumber grading or inspection agency.

(2) Where permitted under Wis. Adm. Code section Ind 56.06, standard fire escapes may be used for not to exceed one-third of the above total widths.

(3) The capacity of a school building shall be established by the actual number of fixed seats in rooms where such are used or by the number of persons which may be accommodated. (See Wis. Adm. Code section Ind 56.11.) The capacity of a library, museum, or art gallery shall be established on the basis of 100 square feet of total floor area of the building, exclusive of stairways and elevators, to each person, except that for library reading rooms this area shall be reduced to 20 square feet per person for the space so occupied.

**Ind 56.08 Exit doors.** Exit doors shall comply with the requirements of Wis. Adm. Code section Ind 51.15, except that in elementary schools the width may be reduced to 3 feet. The aggregate width of exit doors shall be as required in Wis. Adm. Code section Ind 56.07. No single door or leaf of a double door shall be more than 42 inches wide.

**Ind 56.09 Passageways.** (1) Corridors and passageways shall be so designed as to prevent congestion and confusion and shall be provided with windows and artificial light so as to maintain a light intensity throughout of not less than 2.5 foot candles at the floor line whenever the building is occupied.

(2) The minimum unobstructed width of corridors and passageways which are used by the public or by the occupants generally, shall be determined in the same manner as specified for stairways in Wis. Adm. Code section Ind 56.07, but in no case shall this width be less than 4 feet. Corridors and passageways serving as a means of egress shall be at least equal in combined width to the required width of the stairways or passageways leading to them.

**Ind 56.10 Access to attic and roof.** Every building more than one story in height shall have permanent means of access to the roof and attic space from inside the building. Where a scuttle opening is provided, the opening shall be not less than 20 x 30 inches, with a permanent enclosure for a stairway or ladder leading thereto.

**Ind 56.11 Floor space and ceiling height.** (1) All class and recitation rooms shall have a minimum floor space of 23 square feet per person. Rooms used only for study purposes shall have a minimum floor space of 15 square feet per person.

(2) In colleges or universities, classrooms seated with tablet arm chairs or seats without desks shall have a minimum floor space of 10 square feet per person.

(3) All rooms used for educational purposes shall not be less than 9 feet high in the clear except that school buildings which have a sloping ceiling may have a ceiling height of not less than 8 feet on the low side of the classroom provided the average ceiling height is not less than 9 feet in the clear. Beams, girders, or other structural members spaced not less than 4 feet on centers which support the ceiling construction shall not be less than 7 feet 6 inches above the floor. Toilet rooms, service rooms, store rooms and similar spaces shall not be less than 7 feet 6 inches in the clear.

History: 1-2-56; am. (3), Register, September, 1959, No. 45, eff. 10-1-59; am. Register, January, 1961, eff. 2-1-61.

**Ind 56.12 Basement rooms.** (1) Where classrooms in school buildings have floors more than 2 feet below the adjoining grade, such rooms

shall comply with the following conditions in addition to the requirements of Wis. Adm. Code section Ind 56.11 and the school lighting code.

(a) All walls and floors which are in contact with the soil shall be moisture-proof and insulated.

History: 1-2-56; am. Register, December, 1962, No. 84, eff. 1-1-63.

**Ind 56.13 Assembly rooms.** A room which seats, or which can accommodate, 100 or more persons shall conform to the requirements of chapter Ind 55 (Theaters and Assembly Halls) of this code except that the minimum width of any exit doorway used exclusively by elementary school children may be 3 feet; but in any case the aggregate width of such doorways shall be in accordance with Wis. Adm. Code chapter Ind 55.

**Ind 56.14 Seats, desks and aisles.** (1) Seats, chairs and desks in class, recitation, or study rooms seating more than 50 persons shall be securely fastened to the floor; or seats shall be fastened together in groups of 4 or more, or in groups of 2 seats and 2 desks. Except that this requirement shall not apply to desks and chairs used by teachers, or to chairs, tables and equipment used in kindergarten rooms.

(2) Class, recitation and study rooms shall have aisles along all walls.

(3) In elementary school rooms, the intermediate aisles shall be not less than 18 inches and the wall aisles not less than 30 inches in width.

(4) In high school rooms, and in all other class, recitation and study rooms, the intermediate aisles shall be not less than 20 inches and wall aisles not less than 30 inches in width.

(5) Where rooms are used for assembly purposes, seats and aisles shall conform to the requirements of Wis. Adm. Code sections Ind 55.13–Ind 55.17.

**Ind 56.15 Heating plants.** (1) In every building more than one story in height, all heating plants and fuel rooms shall be enclosed with not less than 4-hour fire-resistive construction as specified in Wis. Adm. Code sections Ind 51.05 and Ind 51.06. All openings shall be protected with self-closing fire-resistive doors as specified in Wis. Adm. Code section Ind 51.09.

(2) In one story buildings all heating plants and fuel rooms shall be enclosed with not less than 2-hour fire-resistive construction as specified in Wis. Adm. Code sections Ind 51.05 and Ind 51.06, except that this requirement shall not apply to buildings where jacketed stoves or school room heaters are permitted. All openings shall be protected by self-closing fire-resistive doors as specified in Wis. Adm. Code section Ind 51.09.

**Ind 56.16 Sanitary equipment.** (1) TOILETS. School buildings shall have the following toilet equipment:

(a) In high schools, one water-closet for every 30 females or fraction.

(b) One water-closet for every 60 males or fraction and one urinal for every 30 males or fraction.

(c) In junior high and elementary schools, one water-closet for every 25 females or fraction, one water-closet for every 50 males or fraction and one urinal for every 25 males or fraction.

(2) DRINKING WATER. One drinking fountain shall be installed in each story and basement, for each 6000 square feet of classroom

(b) In garages or service stations which are heated by a suspended furnace located in a utility room or storage room, the enclosing walls, floor and ceiling shall be of 2-hour fire-resistive construction unless one side of the room is left open.

(4) FLOOR PITS. There shall be no pits or other depressions in the floor of any garage area, except that this requirement shall not apply to the shallow depressions formed to secure floor drainage, nor to catch basins installed in compliance with the provisions of the plumbing code issued by the state board of health nor to floor openings for access to regular basements.

(a) This will permit service openings in the floors of garages or service stations provided that the area below can be classed as regular basements and are ventilated in accordance with the requirements of the heating, ventilation and air conditioning code.

History: 1-2-56; r. and recr. (2) (c), Register, September, 1959, No. 45, eff. 10-1-59; am. Register, January, 1961, No. 61, eff. 2-1-61.

**Ind 57.51 Filling stations; buildings and structures.** (1) DEFINITIONS. (a) By filling station is meant one or more pumps, tanks, and other pieces of equipment used in the storage and dispensing of liquid fuels and arranged for the sale of such liquid fuels to the public.

(b) By dispensing area is meant any area within 15 feet of any pump or other dispensing equipment.

(c) By basement or open space under a floor or dispensing area is meant any space that does not have an outlet at its lowest level, at or above grade.

(2) CONSTRUCTION. (a) All buildings having a service space of more than 500 square feet in area, designed to accommodate motor driven vehicles, and all other buildings erected within 15 feet of the dispensing equipment shall be of ordinary construction as specified in section Ind 51.02, or better, except where canopies are provided over the dispensing equipment, such canopies shall be of incombustible construction throughout.

1. Pumps or other dispensing equipment serving liquid fuel to the public which are located within or under any occupied part of any building or structure shall be installed in compliance with the provisions of the flammable liquids code.

(b) Buildings not more than one story in height and not exceeding 500 square feet in area may be of frame construction if located at least 15 feet from dispensing equipment and 10 feet from the boundary lines between premises and from other buildings on the same premises.

(c) Buildings more than 500 square feet in area used as office buildings exclusively, or in connection with other non-hazardous occupancies may be of frame construction if not more than one story in height and located at least 30 feet from boundary lines between premises, from other buildings on the same premises and from the dispensing equipment.

(d) All walls, or parts of walls, in buildings under (a) which are nearer than 5 feet to a boundary line between premises or to any other building shall be unpierced; all walls, or parts of walls nearer than 10 feet, but not nearer than 5 feet, to a boundary line between

premises or to any other building shall have all openings therein protected by means of fire-resistive doors and windows as specified in sections Ind 51.09 and Ind 51.10.

(e) The main floor level of any building erected within 15 feet of equipment used to dispense liquid fuel shall not be below the level of the driveway or grade at such equipment.

(f) There shall be no basement or other open space under the floor of the dispensing area outside of the building. There shall be no basement or other open space under the floor of any filling station building, unless:

1. The main floor level is at least 6 inches above the driveway or grade at the dispensing equipment, and

2. There is no outside door, window or other wall opening to such under floor space, except fuel chutes or other similar vertical openings having a tight-fitting cover, with the bottom of such opening at least 6 inches above the driveway or grade at the dispensing equipment.

3. The floor and enclosure of the under floor space is of 4-hour fire-resistive construction as specified in sections Ind 51.05 and Ind 51.06.

4. The under floor space is effectively vented by gravity means.

*Note:* **For requirements applying to floor pits, see section Ind 57.50.**

**History: 1-2-56; am. (2) (a); cr. (2) (a) 1., Register, September, 1959, No. 45, eff. 10-1-59.**

**Ind 57.52 Automobile tire or battery shops.** (1) Any building, or part of a building, in which tires are repaired or fitted to vehicles shall be constructed, equipped and maintained as a garage under section Ind 57.50.

(2) Any building or part of a building, in which electric storage batteries are charged, repaired, or are installed in vehicles shall be constructed, equipped and maintained as a garage under section Ind 57.50.

Ind 57.53 Automobile parking decks. (1) DEFINITION. For the purpose of this code, a parking deck is an unenclosed or partially enclosed structure used for the parking or storage of self-propelled vehicles, which are driven into the structure and are parked under their own power with no facilities for the repairing of such vehicles.

(2) CONSTRUCTION REQUIREMENTS. (a) Parking decks may be erected without enclosing walls except that unpierced enclosing walls of not less than 2-hour fire-resistive construction, as specified in Wis. Adm. Code section Ind 51.05, shall be provided on all sides which are located less then 10 feet from the boundary line between premises or from any other building.

(b) Parking decks of 4-hour fire-resistive construction shall not be limited in height or in floor area.

(c) Parking decks having floor and supporting members of 2-hour fire-resistive construction or better shall not exceed 75 feet in height or 40,000 square feet in area. This area may be increased to 50,000 square feet where the structure faces 2 streets and to 60,000 square feet where the structure faces 3 or more streets.

(d) Parking decks of unprotected incombustible construction shall not exceed 50 feet in height or 20,000 square feet in area. This area may be increased to 25,000 square feet where the structure faces 2 streets and to 30,000 square feet where it faces 3 or more streets.

(e) A continuous wheel guard not less than 10 inches in height shall be provided on all sides of the structure on all floors.

(f) A guard rail not less than 3 feet 6 inches in height and having an intermediate rail at mid-height and a toeboard at least 6 inches high at the base, or the equivalent, shall be provided on all open sides of the structure on each floor.

(g) All parking decks and parts thereof shall be designed and constructed to support the following minimum superimposed live loads in pounds per square foot of horizontal area, in addition to the dead load:

| *Passenger Cars Only* | *Pounds Per Square Foot* |
|---|---|
| Top floor | 80 |
| First floor | 80 |
| Intermediate floors | 50 |
| Ramps | 80 |

| *Busses and Trucks* | |
|---|---|
| All floor and ramp areas | 8,000 pound axle load in any possible position or 80 pounds per square foot, whichever produces the greater stress. |

**History:** Cr. Register, June, 1956, No. 6, eff. 7-1-56; cr. (2) (g), Register, August, 1957, No. 20, eff. 9-1-57; am. Register, December, 1962, No. 84, eff. 1-1-63.