Ind 51,53

Filed May 27, 1974
9:00 am
GLP

STATE OF WISCONSIN)
) SS
DEPARTMENT OF INDUSTRY,)
LABOR AND HUMAN RELATIONS)

TO ALL TO WHOM THESE PRESENTS SHALL COME, GREETINGS:

I, Stephen J. Reilly, Executive Secretary of the Department of Industry, Labor and Human Relations, and custodian of the official records of said Department, do hereby certify that the attached rules to Wisconsin Administrative Code Chapters Ind 50-59--Building and Heating, Ventilating and Air Conditioning Code, were adopted by the Department of Industry, Labor and Human Relations on May 13, 1974.

I further certify that said copy has been compared by me with the original on file in this Department and that the same is a true copy thereof and of the whole of such original.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the official seal of the Department at the Capitol, in the City of Madison, this 13 day of May, A.D., 1974.

Stephen J. Reilly, Executive Secretary

ORDER OF

DEPARTMENT OF INDUSTRY, LABOR AND HUMAN RELATIONS

Pursuant to authority vested in the Department of Industry, Labor and Human Relations by sections 101.01 to 101.20, Wis. Stats., the Department of Industry, Labor and Human Relations hereby creates, repeals and recreates, and adopts rules of Wisconsin Administrative Code Chapters Ind 50-59--Building and Heating, Ventilating and Air Conditioning Code.

The rules attached hereto shall become effective on January 1, 1975, following publication in the Wisconsin Administrative Code as provided in section 227, Wis. Stats., with the following exception:

Section Ind 53.26 shall become effective on January 1, 1976.

NOTICE: Sections Ind 51.25, 51.26 and 51.27 following are effective January 1, 1975.

Section Ind 51.25 to be repealed and recreated to read:

Ind 51.25 Adoption of ASTM Standards. Pursuant to section 227.025, Wis. Stats., the attorney general and the revisor of statutes have consented to the incorporation by reference of the following standards of the American Society of Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pa. 19103. Copies of the standards in reference are on file in the offices of the department, the secretary of state, and the revisor of statutes.

(1) GENERAL REQUIREMENTS FOR DELIVERY OF ROLLED STEEL PLATES, SHAPES, SHEET PILING AND BARS FOR STRUCTURAL USE. Part 4 ASTM Designation A 6-72.

(2) STRUCTURAL STEEL. Part 4 ASTM Designation A 36-70a.

(3) COLD-DRAWN STEEL WIRE FOR CONCRETE REINFORCEMENT. Part 4 ASTM Designation A 82-72.

(4) ZINC-COATED (GALVANIZED) IRON OR STEEL FARM-FIELD AND RAILROAD RIGHT-OF-WAY WIRE FENCING. Part 3 ASTM Designation A 116-71.

(5) ZINC COATING (HOT-DIP) ON IRON AND STEEL HARDWARE. Part 3 ASTM Designation A 153-73.

(6) DEFORMED AND PLAIN BILLET-STEEL BARS FOR CONCRETE REINFORCEMENT. Part 4 ASTM Designation A 615-72.

(7) RAIL-STEEL DEFORMED AND PLAIN BARS FOR CONCRETE REINFORCEMENT. Part 4 ASTM Designation A 616-72.

(8) AXLE-STEEL DEFORMED AND PLAIN BARS FOR CONCRETE REINFORCEMENT. Part 4 ASTM Designation A 617-72.

(9) GYPSUM. Part 9 ASTM Designation C 22-50(1972).

(10) CHEMICAL ANALYSIS OF LIMESTONE, QUICKLIME, AND HYDRATED LIME. Part 9 ASTM Designation C 25-72.

(11) STRUCTURAL CLAY LOAD-BEARING WALL TILE. Part 12 ASTM Designation C 34-62(1970).

(12) COMPRESSIVE STRENGTH OF CYLINDRICAL CONCRETE SPECIMENS. Part 10 ASTM Designation C 39-72.

(13) OBTAINING AND TESTING DRILLED CORES AND SAWED BEAMS OF CONCRETE. Part 10 ASTM Designation C 42-68.

(14) SAMPLING, INSPECTION, PACKING, AND MARKING OF LIME AND LIMESTONE PRODUCTS. Part 9 ASTM Designation C 50-57(1968).

(15) GYPSUM PARTITION TILE OR BLOCK. Part 12 ASTM Designation C 52-54(1972).

(16) CONCRETE BUILDING BRICK. Part 12 ASTM Designation C 55-71.

(17) STRUCTURAL CLAY NON-LOAD-BEARING TILE. Part 12 ASTM Designation C 56-71.

(18) STRUCTURAL CLAY FLOOR TILE. Part 12 ASTM Designation C 57-57(1972).

(19) BUILDING BRICK (SOLID MASONRY UNITS MADE FROM CLAY OR SHALE). Part 12 ASTM Designation C 62-69.

(20) SAMPLING AND TESTING BRICK. Part 12 ASTM Designation C 67-66.

(21) HOLLOW LOAD-BEARING CONCRETE MASONRY UNITS. Part 12 ASTM Designation C 90-70.

(22) MASONRY CEMENT. Part 9 ASTM Designation C 91-71.

(23) ABSORPTION AND BULK SPECIFIC GRAVITY OF NATURAL BUILDING STONE. Part 12 ASTM Designation C 97-47(1970).

(24) MODULUS OF RUPTURE OF NATURAL BUILDING STONE. Part 12 ASTM Designation C 99-52(1970).

(25) PHYSICAL TESTING OF QUICKLIME AND HYDRATED LIME. Part 9 ASTM Designation C 110-71.

(26) SAMPLING AND TESTING STRUCTURAL CLAY TILE. Part 12 ASTM Designation C 112-60 (1970).

(27) Not used.

(28) SAMPLING AND TESTING CONCRETE MASONRY UNITS. Part 12 ASTM Designation C 140-70.

(29) AGGREGATE FOR MASONRY MORTAR. Part 12 ASTM Designation C 144-70.

(30) SOLID LOAD-BEARING CONCRETE MASONRY UNITS. Part 12 ASTM Designation C 145-71.

(31) PORTLAND CEMENT. Part 9 ASTM Designation C 150-73a.

(32) COMPRESSIVE STRENGTH OF NATURAL BUILDING STONE. Part 12 ASTM Designation C 170-50(1970).

(33) HYDRATED LIME FOR MASONRY PURPOSES. Part 9 ASTM Designation C 207-49(1968).

(34) MORTAR FOR UNIT MASONRY. Part 12 ASTM Designation C 270-71.

(35) GYPSUM CONCRETE. Part 9 ASTM Designation C 317-64(1970).

(36) MICROSCOPICAL DETERMINATION OF AIR-VOID CONTENT AND PARAMETERS OF THE AIR-VOID SYSTEM IN HARDENED CONCRETE. Part 10 ASTM Designation C 457-71.

(37) CHEMICAL ANALYSIS OF GYPSUM AND GYPSUM PRODUCTS. Part 9 ASTM Designation C 471-72.

(38) PHYSICAL TESTING OF GYPSUM PLASTERS AND GYPSUM CONCRETE. Part 9 ASTM Designation C 472-73.

(39) PHYSICAL TESTING OF GYPSUM BOARD PRODUCTS AND GYPSUM PARTITION TILE OR BLOCK. Part 9 ASTM Designation C 473-68.

(40) MORTAR AND GROUT FOR REINFORCED MASONRY. Part 12 ASTM Designation C 476-71.

(41) HOLLOW BRICK (HOLLOW MASONRY UNITS MADE FROM CLAY OR SHALE). Part 12 ASTM Designation C 652-70.

(42) RESISTANCE OF CONCRETE TO RAPID FREEZING AND THAWING. Part 10 ASTM Designation C 666-73.

(43) ESTABLISHING STRUCTURAL GRADES AND RELATED ALLOWABLE PROPERTIES FOR VISUALLY GRADED LUMBER. Part 16 ASTM Designation D 245-70.

(44) EVALUATING THE PROPERTIES OF WOOD-BASE FIBER AND PARTICLE PANEL MATERIALS. Part 16 ASTM Designation D 1037-72a.

(45) LOAD-SETTLEMENT RELATIONSHIP FOR INDIVIDUAL PILES UNDER STATIC AXIAL LOAD. Part 11 ASTM Designation D 1143-69.

(46) CONDUCTING STRENGTH TESTS OF PANELS FOR BUILDING CONSTRUCTION. Part 14 ASTM Designation E 72-68.

(47) SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS. Part 14 ASTM Designation E 84-70.

(48) FIRE TESTS OF ROOF COVERINGS. Part 14 ASTM Designation E 108-58(1970).

(49) FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS. Part 14 ASTM Designation E 119-73.

(50) NONCOMBUSTIBILITY OF ELEMENTARY MATERIALS. Part 14 ASTM Designation E 136-73.

(51) BOND STRENGTH OF MORTAR TO MASONRY UNITS. Part 14 ASTM Designation E 149-66.

(52) FIRE TESTS OF DOOR ASSEMBLIES. Part 14 ASTM Designation E 152-73.

(53) FIRE TESTS OF WINDOW ASSEMBLIES. Part 14 ASTM Designation E 163-65(1972).

(54) COMPRESSIVE STRENGTH OF MASONRY ASSEMBLAGES. Part 14 ASTM Designation E 447-72.

Section Ind 51.26 to be repealed and recreated to read:

Ind 51.26 Adoption of ACI Standards. Pursuant to section 227.025, Wis. Stats., the attorney general and the revisor of statutes have consented to the incorporation by reference of the following standards of the American Concrete Institute (ACI), P. O. Box 4754, Redford Station, Detroit, Michigan 48219. Copies of the standards in reference are on file in the offices of the department, the secretary of state, and the revisor of statutes.

(1) BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE. ACI 318-71.

(2) RECOMMENDED PRACTICE FOR MANUFACTURED REINFORCED CONCRETE FLOOR AND ROOF UNITS. ACI 512-67.

(3) MINIMUM REQUIREMENTS FOR THIN-SECTION PRECAST CONCRETE CONSTRUCTION. ACI 525-63.

Section Ind 51.27 to be created to read:

Ind 51.27 Adoption of Miscellaneous Standards. Pursuant to section 227.025, Wis. Stats., the attorney general and the revisor of statutes have consented to the incorporation by reference of the following standards. Copies of the standards in reference are on file in the offices of the department, the secretary of state, and the revisor of statutes.

(1) Aluminum Association (The), 750 Third Avenue, New York City 10017, SPECIFICATIONS FOR ALUMINUM STRUCTURES, Aluminum Construction Manual, Section 1, second edition, November 1971.

(2) American Institute of Steel Construction, 101 Park Avenue, New York, N. Y. 10017, SPECIFICATION FOR THE DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS, February 12, 1969; and COMMENTARY ON THE SPECIFICATIONS FOR THE DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDINGS, February 12, 1969.

(3) American Institute of Timber Construction, 333 West Hampden Ave., Englewood, Colorado 80110, STANDARD SPECIFICATIONS FOR STRUCTURAL GLUED LAMINATED TIMBER OF DOUGLAS FIR, WESTERN LARCH, SOUTHERN PINE AND CALIFORNIA REDWOOD, AITC 117-71; STANDARD SPECIFICATIONS FOR HARDWOOD GLUED LAMINATED TIMBER, AITC 119-71; STANDARD SPECIFICATIONS FOR STRUCTURAL GLUED LAMINATED TIMBER USING "E" RATED AND VISUALLY GRADED LUMBER OF DOUGLAS FIR, SOUTHERN PINE, HEM-FIR, AND LODGEPOLE PINE, AITC 120-71.

(4) American Iron and Steel Institute, 150 East 42nd St., New York, N. Y. 10017, SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS, 1968 edition, including Addendum No. 1, Nov. 19, 1970; SPECIFICATION FOR THE DESIGN OF LIGHT GAGE, COLD-FORMED STAINLESS STEEL STRUCTURAL MEMBERS, 1968 edition.

(5) American National Standards Institute, Inc., 1430 Broadway, New York, N. Y. 10018, SPECIFICATION FOR REINFORCED GYPSUM CONCRETE, ANSI A 59.1-1968 (Rev. 1972); SPECIFICATION FOR VERMICULITE CONCRETE ROOFS AND SLABS ON GRADE, ANSI A 122.1-1965.

(6) American Welding Society, 2501 NW 7th Street, Miami, Florida 33125, STRUCTURAL WELDING CODE, AWS D 1.1-72.

(7) American Wood Preservers' Association, 1625 Eye Street NW, Washington, D. C. 20006, ALL TIMBER PRODUCTS, STANDARD FOR PRESERVATIVE TREATMENT BY PRESSURE PROCESSES, AWPA C 1-73; LUMBER, TIMBERS, BRIDGE TIES AND MINE TIES, PRESERVATIVE TREATMENT BY PRESSURE PROCESSES, AWPA C 2-73; ROUND POLES AND POSTS USED IN BUILDING CONSTRUCTION--PRESERVATIVE TREATMENT BY PRESSURE PROCESSES, AWPA C 23-72.

(8) National Forest Products Association (Recommended by), 1619 Massachusetts Ave. NW, Washington, D. C. 20036, NATIONAL DESIGN SPECIFICATION FOR STRESS-GRADE LUMBER AND ITS FASTENINGS, 1973 edition, including SUPPLEMENT TO 1973 EDITION, dated April 1973.

(9) Steel Joist Institute, 2001 Jefferson Davis Highway, Arlington, Virginia 22202, STANDARD SPECIFICATIONS AND LOAD TABLES, 1973.

(10) Truss Plate Institute, 919 18th Street NW, Washington, D. C. 20006, DESIGN SPECIFICATIONS FOR LIGHT METAL PLATE CONNECTED WOOD TRUSSES, TPI-74.

(11) Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402, U.S. PRODUCT STANDARDS PS 1-66 for softwood plywood/construction and industrial, including all amendments through No. 6, dated June 8, 1970 (National Bureau of Standards).

NOTICE: The rules of Chapter Ind 53 following are effective January 1, 1975.

CHAPTER IND 53, STRUCTURAL REQUIREMENTS

Chapter Ind 53, Structural Requirements, to be repealed and recreated to read:

Ind 53.01 SCOPE. This chapter provides the minimum requirements for the structural design of all buildings, structures and foundations to provide safe support of all dead loads, superimposed live and special loads, without exceeding the prescribed allowable stresses or departing from accepted engineering practice.

Note: References. All standards referred to in this chapter will be identified by the designation and the number of standard followed by a cross-reference. The cross-reference will give full detail of the subject name and year of standard. Example: ASTM C-55 [Ind 51.25 (16)].

MINIMUM ALLOWABLE LOADS.

Ind 53.10 DEAD LOADS. All buildings and structures, and parts thereof, shall be designed and constructed to support the actual dead weight of all component members in addition to the weight of partitions, ceiling finishes, floor finishes, stairways, safes and service equipment such as sprinkler systems, plumbing stacks, heating and air conditioning equipment, electrical equipment, elevators, flues and similar fixed equipment which become a part of the building.

Note: Unless the project owner submits a written application for waiver, the department will consider 3 pounds per square foot as minimum service equipment load.

Ind 53.11 LIVE LOADS. (1) All buildings and structures, and parts thereof, shall be designed and constructed to support the superimposed live loads, specified in Table 53-I, uniformly distributed in pounds per square foot of horizontal area. These 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. The most severe distribution, concentration and combination of design loads and forces shall be taken into consideration.

TABLE 53-I

FLOOR LOADINGS

Occupancy	PSF
(a) Business	
1. Offices	50
2. Offices with heavy business machines, heavy files, book stacks	100
(b) Mercantile	
1. Retail stores, shops, banks, restaurants, taverns, funeral homes	100
2. Wholesale stores	125

Table 53-I (cont.)

Occupancy	PSF
(c) Industrial	
1. Manufacturing, light	100
2. Manufacturing, heavy	150
(d) Storage	
1. Warehouse, light	125
2. Warehouse, heavy	250
3. Paper storage	
a. Compact	.50 psf per ft. of ht.
b. Loose	.30 psf per ft. of ht.
4. Garages--storage or repair or 8,000 pound axle load in any possible position (whichever produces larger stresses).	80
5. Parking decks	
a. All areas for passenger cars	50
b. Top floors, if open to sky, shall comply with Ind 53.11(4) (roof loads) in addition to	50
c. Express lanes and ramps with a slope of 12% or more, the vertical loading (50 psf) shall be increased by 25%	
d. All areas for trucks and buses or 8,000 pound axle load in any possible position (whichever produces larger stresses)	80
(e) Assembly areas	
1. Armories, drill rooms	150
2. Assembly halls, auditoriums, lecture halls, churches, lodge rooms, theaters, courtrooms, balconies, with:	
a. Fixed seats	60
b. Movable seats	100
3. Dance floors, gymnasiums, exhibition rooms, passenger stations, skating rinks, restaurant serving and dining areas	100
4. Recreational areas such as bowling alleys and pool rooms	75

Table 53-I (cont.)

Occupancy	PSF
5. Floors supporting portable reviewing stands, grandstands or bleachers	130
Note: See Ind 55.56 for designing of portable units.	
6. Stage floors	150
(f) Educational	
1. Schools and related facilities	
a. Classrooms, study rooms, laboratories, display areas, offices.	50
b. Floors of open plan schools.	75
c. Industrial arts, home economics, music and band rooms.	80
d. Gymnasiums, cafeteria areas.	100
2. Libraries (public or in schools)	
a. Reading areas.	60
b. Stack areas (20 psf per foot of height) but not less than.	150
3. Museums and art galleries.	80
(g) Residential	
1. Apartments, dormitories, guest rooms in hotels and motels.	40
(h) Institutional	
1. Ward and private rooms in hospitals, nursing homes, asylums, cells in penal institutions	40
2. Operating rooms in hospitals, clinics.	60
(i) Miscellaneous (applies to all occupancies above)	
1. Stairways, corridors, vestibules, lobbies	
a. in residential and institutional buildings	80
b. in all other buildings	100
2. Rest rooms and toilet rooms in public places	50
3. Equipment rooms (heating-ventilating, mechanical, electrical) equipment weight plus 40 psf, but not less than.	75

Table 53-I (cont.)

Occupancy	PSF
4. Structural sidewalks and promenade decks	
a. with no vehicular restriction or 12,000 pounds concentrated load in any position	250
b. with vehicular restriction	100

(2) Loads not specified in Table 53-I. See Ind 53.11 (1).

(3) Live load reductions.

(a) No reduction of live load shall be allowed in the design of any slab or joist.

(b) No reduction of live load shall be allowed in the occupancies mentioned in Table 53-I subsections (d) storage and (e) assembly areas.

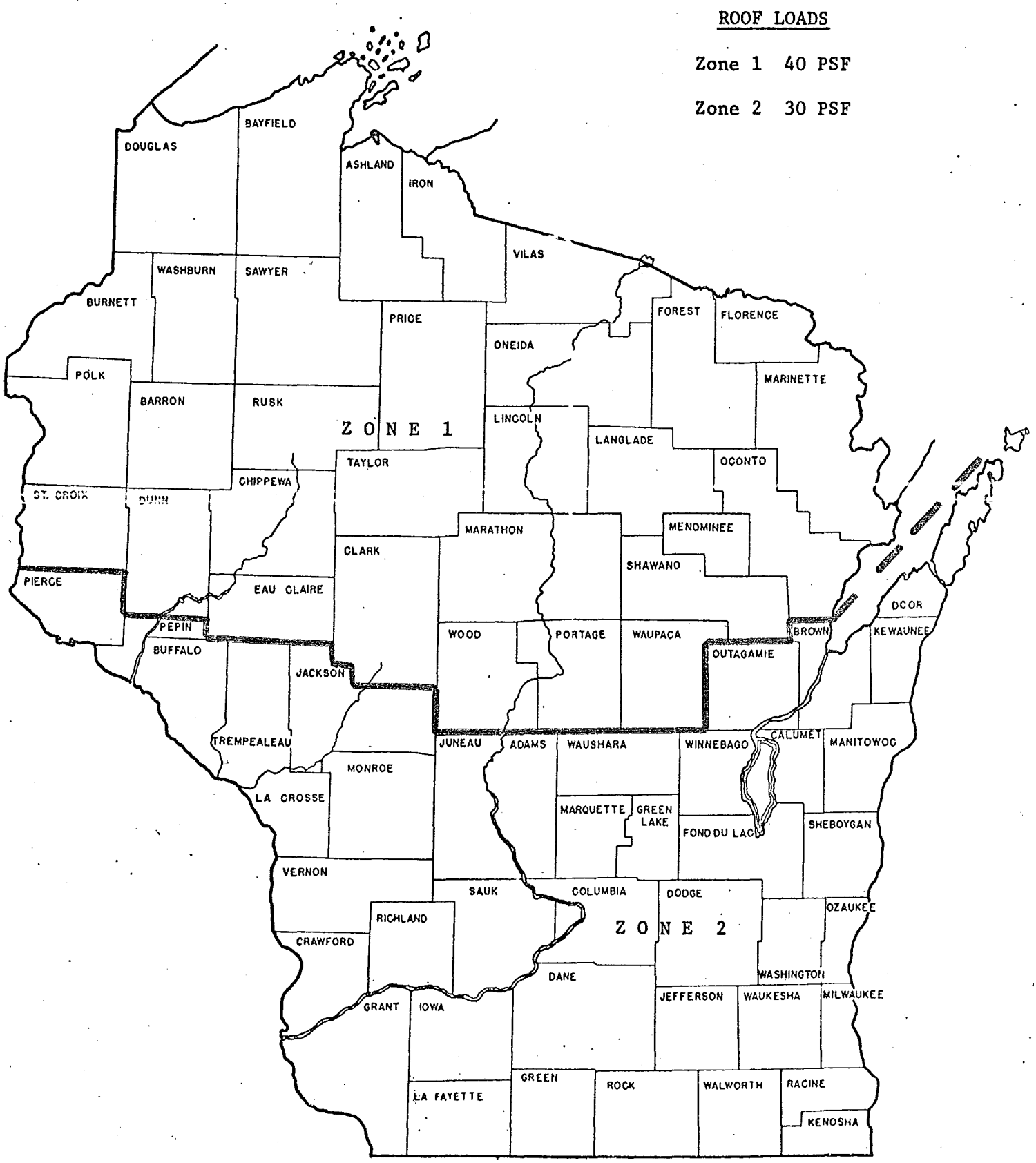
(c) For determining the total live load carried by foundations, columns, piers and walls, the following reductions can be applied to the entire floor area tributary to these members:

carrying the roof	0%
carrying 1 floor and roof	0%
carrying 2 floors and roof	10%
carrying 3 floors and roof	20%
carrying 4 floors and roof	25%
carrying 5 floors and roof	30%
carrying 6 floors and roof	35%
carrying 7 floors and roof	40%
carrying 8 floors and roof	45%
carrying 9 or more floors and roof	50%

(d) A reduction in live load of one percent per twenty (20) square feet is allowed for beams and girders which have a tributary area in excess of 150 square feet. The maximum reduction should not exceed 15 percent and such reduction shall not be carried into the structural members supporting these beams and girders.

(4) Roof loads. Roof loads shall be as indicated in the zone map for roof loads. (The loads are to be applied to horizontal projections.)

ZONE MAP FOR ROOF LOADS



(a) Special-purpose roofs. Greenhouses shall be designed for not less than 20 pounds per square foot.

(b) Increase in roof loads. When there are elevation differences on roof levels, parapets, canopies or valleys which may cause excess snow, ice and/or water accumulation, the designer shall make special provisions for increased loading at such locations.

Note: The department will accept special provisions such as outlined in, but not limited to "Structural Information for Building Design in Canada," Supplement No. 3, National Building Code of Canada; or the recommendations of the Metal Building Manufacturers Association.

Ind 53.12 WIND LOADS.

(1) Loading. Every building (including all components of the exterior wall) and structure shall be designed to resist a minimum total wind load in accordance with the following table:

Up to 50 feet	20 psf
Over 50 to 100 feet	25 psf
Over 100 to 150 feet	30 psf
Over 150 to 200 feet	35 psf
Over 200 feet	40 psf

The wind pressure shall be taken on the gross area of the vertical projection of the building or structure facing the wind. No allowance shall be made for the shielding effect of other buildings and structures. For purposes of wind load design, the height shall be measured above the average level of the adjoining ground.

(2) Uplift and suction forces. Buildings and structures, including attachment of roof to building or structure and anchorage of building or structure to the foundation, shall be designed and constructed to withstand a wind pressure acting outward normal to the surface equal to the values set forth in Ind 53.12 (1). These suction and uplift forces need not be considered as additive to the design wind loads in the overall analysis of the building or structure.

(3) Overturning moment. The overturning moment due to wind load shall not exceed 2/3 (two-thirds) of the moment of stability due to dead load only, unless the building or structure is anchored to foundations of sufficient weight to resist this force. The weight of earth superimposed over footings may be used to calculate the dead load resisting moment. Sufficient diaphragm bracing, diagonal bracing or rigid connections between uprights and horizontal members shall be provided to resist distortions.

(4) Shape factors. The following shape factors may be used for the design of structures such as chimneys, tanks and solid towers in conjunction with Ind 53.12 (1).

Horizontal cross-section	Shape factors
square or rectangular	1.0
hexagonal or octagonal	0.8
round or elliptical	0.6

(5) Wind load analysis. More exact wind load analysis will be acceptable if a recognized procedure is used.

Note: The department will accept recognized procedures such as, but not limited to Department of Navy, Bureau of Yards and Docks, NAVFAC DM-2 (Dec. 1967); or "Wind Forces on Structures," by the Structural Division of ASCE, Test Committee on Wind Forces (ASCE Transactions, Vol. 126, Part II, Paper No. 3269).

Ind 53.13 IMPACT LOADS.

(1) Loading. Structural elements carrying live loads which induce impact shall have the live loads increased by the following minimum percentages in the structural design consideration of such forces:

For supports of elevators	100
For traveling crane support girders and moving loads	25
For supports of light machinery	20
For supports of vibrating machinery or power driven units	50
For hangers supporting floors and balconies	33

(2) Horizontal and longitudinal crane forces. The lateral force on crane runways shall be equal to 20 percent of the sum of the crane capacity and the crane trolley (but exclusive of other parts of the crane). The force shall be assumed to be applied at the top of the rail, one-half on each side of the runway, and shall be considered acting in either direction normal to the runway rail. The longitudinal force (in the direction of rail) shall be taken as 10 percent of the maximum wheel loads of the crane applied at the top of the rail.

Ind 53.14 LOAD COMBINATIONS. Allowable stresses may be increased 33-1/3 percent when wind loads are acting in combination with dead, live and impact (if any) loads. The section computed on this basis shall be not less than that required for the design dead, live and impact (if any) loads, computed without the 33-1/3 percent stress increase.

FOUNDATIONS

Ind 53.20 GENERAL. All submittals for plan examination of new buildings or structures, and for the alteration of a permanent structure which requires changes in foundation loads and distribution, shall have the soil types and bearing capacities (indicating verified or presumptive) used in the design of footing and foundations shown on the plans. Sufficient records and data to establish the soil character, nature and load-bearing capacity shall be available to the department upon request.

Ind 53.21 SOIL BEARING CAPACITY. Bearing capacity of soils shall be determined by one of the following methods:

(1) Verified. The soil shall be subjected to field or laboratory tests to determine its bearing capacity. A report, certified by a registered architect or registered professional engineer, shall be available to the department upon request.

(2) Presumptive.

(a) The type of soil under buildings shall be assigned a value not exceeding the bearing capacity, in pounds per square foot, as specified in Table 53-II. The type of soil shall be determined by explorations made at or adjacent to the site. The actual loading of the soil shall not exceed the specified bearing capacity unless verified by a written report (as explained in subsection (1) above).

TABLE 53-II

PRESUMPTIVE SOIL BEARING VALUES

Type of Soil	PSF
1. Wet soft clay; very loose silt; silty clay.	Verified method Ind 53.21 (1)
2. Loose fine sand; medium clay; loose sandy clay soils.	2,000
3. Stiff clay; firm inorganic silt	3,000
4. Medium (firm) sand; loose sandy gravel; firm sandy clay soils; hard dry clay	4,000
5. Dense sand and gravel; very compact mixture of clay, sand and gravel. .	6,000
6. Rock.	12,000

(b) Confirmation. The presumed soil bearing values shall be confirmed by exploring the type of soil to a depth of at least 5 feet below the footings during or before construction. The designer shall submit a report of confirmation to the department.

(c) Varying soil strata. Where the bearing materials directly under a foundation overlie a stratum having smaller allowable bearing values, such smaller values shall not be exceeded at the level of such stratum.

Ind 53.22 UNPREPARED FILL MATERIAL, ORGANIC MATERIAL. No foundation of buildings or structures shall be placed upon unprepared fill material, organic soil, alluvial soil or mud unless evidence has been presented to the department showing that the proposed load will be adequately supported. This evidence shall be in the form of a written report and shall be based on soil analyses, load tests or other acceptable criteria.

Ind 53.23 FROST PENETRATION. Footings and foundations shall be placed below the frost penetration level, but in no case less than 42 inches below adjacent ground. Such footings shall not be placed over frozen material.

Exceptions:

(1) The edges of floating slabs constructed on grade need not be installed below the minimum frost penetration line provided adequate measures have been taken to prevent frost forces from damaging the structure.

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

Ind 53.24 PILING.

(1) General requirement. Pile foundations shall be designed and installed to adequately transfer the structure loads to underlying or adjacent soil bearing strata.

(2) Installation. Piles shall be handled and installed to the required penetration by methods which leave their strength unimpaired and that develop and retain the required load bearing capacity. Any damaged pile shall be satisfactorily repaired or the pile shall be rejected.

(3) Allowable loads based on soil conditions.

(a) By driving formula. For individual pile design loads not exceeding 40 tons per pile, the safe working load may be determined by a recognized formula or by the following formula:

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

$$P = \frac{2\ E}{S+0.1} \quad \text{for double-acting hammer}$$

in which:

P = safe load (lbs.)
W = weight of striking part of hammer (lbs.)
H = fall of striking part of hammer (ft.)
E = manufacturer's rated energy (ft. - lbs.)
S = average penetration of pile under last 6 blows (inches/blow)

(b) Substantiation of higher allowable loads. Allowable loads greater than 40 tons will be permitted when substantiating data justifying such higher loads is submitted to the department by a foundation designer knowledgeable in the field of soil mechanics and pile foundations and familiar with the locale of the proposed project. Substantiating data such as test borings, laboratory test results, soil profiles, and pile load tests may be required by the department. The load test shall be in accordance with the procedure outlined in ASTM D-1143 [Ind 51.25 (45)].

(c) Group pile action. When friction piles are placed in groups, consideration shall be given to the reduction of load per pile.

(d) Piles in subsiding areas. Where piles are driven through subsiding fills or other subsiding strata and derive support from underlying firmer material, consideration shall be given to the downward frictional forces which may be imposed on the piles by the subsiding upper strata.

(e) Lateral support. Water, air and fluid soils shall not be considered as offering lateral support to piles. In any other type of material the piles may be designed as a short column. Positive permanent lateral support shall be provided at or near the top of all piles.

(4) Allowable loads based on pile material strength.

(a) The compressive stress in any cross-section of a pile shall not exceed the normal allowable compressive stress of the material used for the pile, except as given in Ind 53.24 (5). The piles may be designed as short columns except as stated in section Ind 53.24 (3) (e).

(b) End-bearing piles. For end-bearing piles more than 40 feet in length, it may be assumed that 75 percent of the load is carried by the tip, except for piles installed in a material referred to in section Ind 53.22.

(c) Friction piles. For friction piles, the full load shall be computed at the cross section located at two-thirds of the embedded length of the pile measured up from the tip.

(5) Type of piles.

(a) Timber piles. Timber piles shall conform to National Design Specifications, Part X [Ind 51.27 (8)]. In addition, the tops of treated piles, at cutoff, shall be given 3 coats of hot creosote, followed by a coat of coal-tar pitch; and the cutoff shall be encased not less than 4 inches in concrete footing of the foundation.

(b) Precast concrete piles. Precast concrete piles shall be cast in one piece and shall attain a compressive strength of not less than 3,000 psi prior to driving. There shall be a minimum concrete covering of 2 inches over all reinforcing bars. Precast concrete piles shall be designed to resist stresses induced by handling, driving and superimposed loads.

(c) Cast-in-place concrete piles. All concrete for cast-in-place piles shall develop a compressive strength of not less than 3,000 psi. Reinforcement shall have a concrete cover of one inch in cased piles and 2 inches in uncased piles.

1. Uncased piles. Cast-in-place piles in contact with earth shall be limited in length to 30 times the average diameter of the pile. The allowable compressive stress in concrete shall not exceed $0.33\ f'_c$. The concrete shall be deposited in a shaft free of foreign matter in a continuous operation so as to insure a full sized pile without voids or segregation.

2. Metal formed piles. Cast-in-place piles in contact with a steel shell or casing shall have a minimum tip diameter of 8 inches and a minimum

average diameter of 10 inches. The shell and casing shall be sufficiently strong to resist collapse and sufficiently watertight to exclude water and foreign material during the placing of concrete. The shell or casing cannot be considered as a load carrying part of the pile. The allowable compressive stress in concrete shall be as stated for uncased piles, but it may be increased to a maximum value of 0.40 f'_c if the following conditions are satisfied:

a. The thickness of casing is not less than 0.0747 inches (14 ga AISI).

b. The casing is seamless or is provided with seams of strength equal to that of the casing.

c. The pile diameter is not greater than 18 inches.

(d) Concrete-filled pipe and tapered tubular piles. Concrete-filled pipe and tapered tubular piles may be driven open-ended or closed-ended. Pipe or tapered tube piles driven with closed ends shall be treated as a cast-in-place concrete pile with metal casing and shall be governed by the same regulations applicable thereto with suitable load-bearing allowance made for the metal casing. When driven open-ended to rock, no concrete shall be deposited until the pipe is cleaned free of all soil or loose rock chips and satisfactory proof furnished of the condition of the rock. The allowable stress in steel is .35 F_y but shall not exceed 12,600 psi. The minimum wall thickness of all load-bearing pipe, tube and shells shall be 1/10 inch. When the soil surrounding the pile contains destructive chemical elements, the pile shall be provided with an approved protective jacket or coating which will not be rendered ineffective by driving.

(e) Structural steel piles. No section shall have a nominal thickness of metal less than 3/8 inch. When an H-shaped section is used, the flange projection shall not be more than 14 times the minimum thickness of metal. The steel stress shall not exceed 0.35 F_y.

Ind 53.25 SETTLEMENT. Where footings or floating slabs are placed upon clays or other materials which are subject to settlement, an analysis for such buildings shall include consideration of total and differential settlements anticipated.

NOTICE: Section Ind 53.26 following is effective January 1, 1976.

Ind 53.26 PROTECTION OF ADJOINING PROPERTY.

(1) Any person making or causing an excavation to be made to a depth of 12 feet or less, below the grade, shall protect the excavation so that the soil of adjoining property will not cave in or settle, but shall not be liable for the expense of underpinning or extending the foundation of buildings on adjoining properties where his excavation is not in excess of 12 feet in depth. Before commencing the excavation the person making or causing the excavation to be made shall notify in writing the owners of adjoining buildings not less than 30 days before such excavation is to be made and that the adjoining buildings should be protected. The owners of the adjoining property shall be given access to the excavation for the purpose of protecting such adjoining buildings.

(2) Any person making or causing an excavation to be made exceeding 12 feet in depth below the grade shall protect the excavation so that the soil of adjoining property will not cave in or settle, and shall extend the foundation of any adjoining buildings below the depth of 12 feet below grade at his own

expense. The owner(s) of the adjoining buildings shall extend the foundations of their buildings to a depth of 12 feet below grade at his own expense as provided in the preceding paragraph.

Ind 53.27 CUT OR FILL SLOPES.

(1) Permanent cut or fill slopes. Cuts or fills adjacent to any building, structure or property line shall be so constructed or protected that they do not endanger life and/or property. Permanent cut slopes shall not be steeper than 1-1/2 horizontal to one vertical and permanent fill slopes shall not be steeper than 2 horizontal to one vertical unless substantiating data justifying steeper slopes are submitted.

(2) Temporary cut or fill slopes. For temporary cuts and fills, refer to Wis. Adm. Codes Chapter Ind 6--Trench, Excavation and Tunnel Construction, and Chapter Ind 35--Safety in Construction.

Ind 53.28 POLE FOUNDATIONS. Structures that use poles embedded in earth or embedded in concrete footings in the earth to resist axial and lateral loads shall have their depth of embedment determined as specified in this section.

(1) Construction backfill requirements. The space around the pole shall be backfilled in accordance with one of the following methods:

(a) The hole shall be made 4 inches larger than the diameter or diagonal dimension of rectangular or square poles. It shall be backfilled with 2,000 psi concrete.

(b) The backfill shall be of thoroughly compacted clean sand.

(2) Design-nonrestrained poles. The following formula shall be used in determining the depth of embedment required to resist lateral loads where no constraint is provided at the ground surface.

$$d = \frac{A}{2} \left(1 + \sqrt{1 + \frac{4.36h}{A}}\right)$$

where: d = depth of embedment, ft.

$A = 2.34P/S_1B$

P = applied horizontal force on pole, lb.

$S_1 = pd/3$, see Table 53-III

Note: For first approximation of "d", the following formula may be used:

$$d = \sqrt[3]{\frac{12\ h\ P}{Bp}}$$

B = diameter of concrete casing, ft.; when nonencased in concrete, diameter or diagonal dimension of square or rectangular pole, ft.

h = height above ground line at which force "P" is applied [if pole has fixity at top, such as provided by knee brace, "P" acts at inflection point (may be assumed at 2/3 h)], ft.

p = allowable lateral passive soil pressure,† psf.

†Unless a more exact soil analysis method is used, the allowable passive soil pressure shall be determined as follows:

TABLE 53-III

ALLOWABLE LATERAL SOIL PRESSURE

Soil Types see Table 53-II	Allowable Passive Soil Pressure, psf per foot of depth below grade	S_1 and S_3 values shall not exceed, psf
1 and 2 (Not well drained)	100	1,500
3 and 4 (Well drained)	200	2,500
5 and 6 (Well drained)	400	8,000

(3) Design--restrained poles. Where constraint is provided at the ground surface, such as a rigid floor or pavement, the depth of embedment shall be in accordance with the following formula:

$$d = \sqrt{\frac{4.25\ Ph}{S_3 B}}$$

where: S_3 = pd, see Table 53-III.

MASONRY

Ind 53.30 GENERAL.

(1) Scope. The requirements of Ind 53.30 through 53.36 herein shall apply to the design, construction and materials used in all masonry and similar work under this code.

(2) Definition. Masonry as used herein shall be considered as any built-up construction or combination of building units or materials of clay, shale, concrete, stone, gypsum, glass, metal or other approved units.

(3) Dimensions. Dimensions specified herein are nominal unless otherwise stated. The actual dimensions may vary from the nominal by the thickness of a mortar joint, but not more than one-half inch.

Ind 53.31 MATERIALS.

(1) General requirements. Components used in the construction of masonry shall be as required in sections Ind 53.311 through Ind 53.316.

(2) Labeling. All packaged materials shall be clearly identified by name (portland cement, masonry cement, lime, gypsum, etc.) and applicable standards which are met.

Ind 53.311 MASONRY UNITS.

(1) General.

(a) Solid and hollow units. A solid masonry unit is a unit whose net cross-sectional area in every plane parallel to the bearing surface is 75% or more of its gross cross-sectional area measured in the same plane. A hollow masonry unit has a net cross-sectional area less than 75% of its gross cross-sectional area.

(b) Quality. All masonry units shall be free from cracks, laminations and other defects or deficiencies, including admixtures and coatings, which may interfere with proper laying of the unit or impair the strength or permanence of the structure.

(c) Used masonry units. Masonry units may be reused when clean, whole and conforming to requirements for new masonry units.

(d) Marking requirements. Masonry units shall be of distinctive design or appearance, or marked so that the manufacturer is identified, as required by the department.

(e) Surface condition at time of use. Every masonry unit shall have all surfaces, to which mortar or grout is to be applied, capable of developing the required strength and bond. Coating or facings permitted and applied to masonry unit surfaces prior to their installation shall not supersede this requirement.

(f) Positioning in structure. Hollow masonry units shall be laid only in positions as tested for compliance.

(2) Clay and shale units. Clay and shale units shall be made of burned clay or shale or mixtures thereof with or without admixtures.

(a) Solid units (brick). Units shall conform to grade SW requirements of ASTM C-62 [Ind 51.25 (19)].

(b) Hollow units (tile and hollow brick).

1. Load-bearing units. Units for use in load-bearing and exterior walls shall conform to grade LBX requirements of ASTM C-34 [Ind 51.25 (11)], or grade SW requirements of ASTM C-652 [Ind 51.25 (41)].

2. Non-load-bearing units. Units for use in non-load-bearing partitions shall be specially marked and shall conform to the requirements of ASTM C-56 [Ind 51.25 (17)]. Such units may also be used for nonstructural purposes in concrete floor construction.

3. Units for floor construction. Units for structural use in floor construction shall conform to grade FT 1 requirements of ASTM C-57 [Ind 51.25 (18)].

(3) Concrete units. Concrete units shall be made with portland cement, water and suitable mineral aggregates, with or without admixtures.

(a) Solid units.

1. Small units (brick). Units shall conform to grade N requirements of ASTM C-55 [Ind 51.25 (16)].

2. Large units (solid block). Units shall conform to grade N requirements of ASTM C-145 [Ind 51.25 (30)].

(b) Hollow units (block). Units shall conform to grade N requirements of ASTM C-90 [Ind 51.25 (21)].

(4) Natural stone. All natural building stone for use in masonry shall be sound and free from loose or friable inclusions, and shall meet the strength and fire resistance requirements for the proposed use. Where the cleavage plane of stone units is pronounced, the stone shall be laid only on its natural bed. Stone exposed to soil, weather or frost action shall be such that the strength and structure of the stone will not be affected when so exposed.

(5) Cast stone. Units covered under this category are homogeneous or faced, dry cast concrete products other than conventional concrete masonry units (brick or block), but of similar size.

(a) Composition. Units shall be made with portland cement, water and suitable mineral aggregates, with or without admixtures, and reinforced if required.

(b) Standards. Units shall have a minimum compressive strength of 6500 psi and a maximum water absorption of 6% when tested as 2 x 2 inch cylinders or cubes.

(6) Architectural precast concrete. Units covered under this category are homogeneous or faced, wet cast non-load-bearing concrete products. Load-bearing precast concrete units shall conform to the requirements of Ind 53.40.

(a) Composition. Units shall be made with portland cement, water and suitable aggregates, with or without admixtures, and reinforced as required.

(b) Standards. Units shall conform to the requirements of Table 53-IV.

TABLE 53-IV

ARCHITECTURAL PRECAST CONCRETE PHYSICAL REQUIREMENTS

Use	Compressive Strength† Minimum (psi)		Water Absorption Maximum (%)	Purposefully Entrained Air Minimum (%)
	Avg. of 3	Individual		
Exposed to freeze-thaw cycles (exterior)	4,500	3,800	8	3
All others (interior)	3,500	3,000	10	--

†Compressive strength shall be determined by procedures outlined in ASTM C-39 [Ind 51.25 (12)] or C-42 [Ind 51.25 (13)].

(7) Gypsum units. Units shall conform to the requirements of ASTM C-52 [Ind 51.25 (15)]. Gypsum units shall not be used in exterior or load-bearing walls or locations exposed to frequent or continuous wetting.

(8) Miscellaneous units. See Ind 50.12 for all other potential masonry units.

Ind 53.312 MORTAR.

(1) General. Mortar as used herein shall be considered as a mixture containing cementitious materials used to permanently bond masonry or other structural elements.

(2) Mortar for unit masonry.

(a) Composition. Conventional mortar shall be composed of cementitious materials, fine aggregates and water. Suitable admixtures are allowed.

(b) Standards. All materials used as ingredients in mortar when delivered to the mixer shall conform to the requirements outlined below:

1. Cementitious materials. See Ind 53.314.

2. Aggregates. Aggregates shall conform to the following requirements and to the requirements of ASTM C-144 [Ind 51.25 (29)].

a. Aggregates shall be graded within the limits of Table 53-V.

TABLE 53-V

MASONRY SAND GRADATION REQUIREMENTS

Sieve Size	Percentage Passing	
	Natural Sand	Manufactured Sand
No. 4	100	100
No. 8	95 to 100	95 to 100
No. 16	70 to 100	70 to 100
No. 30	40 to 75	40 to 75
No. 50	10 to 35	20 to 40
No. 100	2 to 15	10 to 25
No. 200	--	0 to 10

b. The aggregate shall have not more than 50% retained between any 2 consecutive sieves of those listed in Table 53-V, nor more than 25% between the No. 50 and No. 100 sieves.

c. If the fineness modulus varies by more than 0.20 from the value assumed in selecting proportions for the mortar, suitable adjustments shall be made in proportions to compensate for the change in grading.

3. Water. See Ind 53.315.

4. Admixtures. Where metal ties, anchors or reinforcement are imbedded in masonry, chloride, nitrate and sulphate base salts or materials containing same shall not be used in masonry construction.

(c) Requirements. Mortar for masonry shall conform to the property requirements of Table 53-VI and to the requirements of ASTM C-270 [Ind 51.25 (34)] unless otherwise noted in this section. If approved laboratory testing is not conducted to indicate compliance with Table 53-VI, the mortar mix shall be restricted to the provisions of Table 53-VII.

TABLE 53-VI

MORTAR PROPERTY REQUIREMENTS

Mortar Type	Compressive Strength† Min. (psi)	Water Retention Min. (%)	Air Content Max. (%)
M	2,500	75	18
S	1,800	75	18
N	750	75	18
O	350	75	18

†See Ind 53.35 (3).

TABLE 53-VII

MORTAR PROPORTION RESTRICTIONS

Mortar Type	Cementitious Materials (Proportions by Volume)			Aggregate (Measured in a damp loose condition)
	Portland Cement	Masonry Cement	Lime	
Lime Cement Mortar				
M	1	--	1/4	Not less than 2-1/4 and not more than 3 times the sum of the separate volumes of cementitious materials.
S	1	--	over 1/4 to 1/2	
N	1	--	over 1/2 to 1-1/4	
O	1	--	over 1-1/4 to 2-1/2	
Masonry Cement Mortar				
M	1	1	--	
S	1/2	1	--	
N	--	1	--	
O	--	1	--	

(3) Gypsum mortar.

(a) Standards. Gypsum mortar shall be composed of one part of unfibered calcined neat gypsum to not more than 3 parts sand by weight, with sufficient water added for workability.

(b) Use restrictions. Gypsum mortar shall be used only with gypsum tile and block units or as fireproofing.

(4) Miscellaneous mortars.

(a) High bond mortars. See section Ind 50.12 for all such mortars, glues and special additives.

(b) Special use mortars. See Table 53-VIII.

(5) Bond. It is required that sufficient bond be developed to hold the masonry assemblage together and let it act as a single unit.

Note: Initial rate of absorption of masonry units and quantity of entrained air in mortar are factors affecting bond strength.

(6) Mortar use. Masonry shall be laid in mortar of the types listed in Table 53-VIII.

TABLE 53-VIII

MORTAR USE REQUIREMENTS

Kind of Masonry	Types of Mortar Permitted
Load-bearing or non-load bearing masonry in contact with earth	M or S
All other load-bearing masonry	M, S or N
Non-load-bearing masonry in exterior and exposed locations where a high degree of resistance to frost action is desired	M, S or N
All other non-load-bearing walls and partitions	M, S, N or O
Fireproofing	M, S, N, O or gypsum
Special masonry:	
Gypsum partition tile or block	Gypsum
Firebrick or tile	Refractory air setting
Stack or chimney walls	Composed of portland cement, hydrated lime putty and aggregate.

Ind 53.313 MASONRY GROUT. Masonry grout for non-engineered masonry shall be type M, S or N mortar, as used in the construction, to which water is added to produce a consistency for pouring without segregation.

Note: Masonry grout for reinforced masonry shall conform to the requirements of ASTM C-476 [Ind 51.25 (40)].

Ind 53.314 CEMENTITIOUS MATERIALS.

(1) Portland cement. Portland cement shall conform to the requirements of ASTM C-150 [Ind 51.25 (31)].

(2) Masonry cement. Masonry cement shall conform to the requirements of ASTM C-91 [Ind 51.25 (22)].

(3) Hydrated lime. Hydrated lime shall conform to Type S requirements of ASTM C-207 [Ind 51.25 (33)].

(4) Gypsum. Gypsum shall conform to the requirements of ASTM C-22 [Ind 51.25 (9)].

Ind 53.315 WATER. Water shall be clean and free from injurious amounts of oil, acid, alkali, salt, organic matter and other deleterious substances.

Ind 53.316 REINFORCING, TIES AND ANCHORS.

(1) Reinforcing bars. Reinforcing bars shall conform to the requirements of ASTM A-615 [Ind 51.25 (6)], A-616 [Ind 51.25 (7)], and A-617 [Ind 51.25 (8)].

(2) Continuous joint reinforcement.

(a) Material. Ties shall be fabricated from the equivalent of cold drawn wire conforming to the requirements of ASTM A-82 [Ind 51.25 (3)].

(b) Coating. Ties in exterior walls and potentially wet areas shall have noncorrodible cross wires for the intended use. Conformance with Class 3 requirements of ASTM A-116 [Ind 51.25 (4)] is acceptable.

(c) Assembly. Ties shall consist of the equivalent of at least 2 No. 9 steel wire gage longitudinal wires or rods with No. 9 steel wire gage cross wires or rods spaced not over 16 inches apart along each longitudinal wire or rod electrically flush or butt welded to tie the outside wires or rods together and provide mechanical bond.

(d) Limitations. Ties shall be of such dimensions that they provide the following:

1. Overlap of at least 6 inches at splices.

2. Engagement of both adjacent wythes; out-to-out spacing of side rods to be approximately 2 inches less than the total wall thickness.

3. Minimum actual cover over all but the cross wires or rods of 5/8 inch clear from all masonry unit faces and their joint surfaces.

(3) Individual ties and anchors.

(a) Material. Ties and anchors shall be fabricated from steel, brass, bronze or other approved material. See Ind 53.322 (5) (c) 1. b.

(b) Coating. Ties and anchors for use in exterior walls and potentially wet areas shall be noncorrodible for the intended use. Zinc coating (hot dip) conforming to the requirements of ASTM A-153 [Ind 51.25 (5)] is acceptable.

(c) Limitations. Ties and anchors shall be of such a dimension as to engage masonry units a minimum of 2 inches on each wythe in which the tie is placed and retain a minimum actual cover of 5/8 inch clear from all exposed masonry faces and joints.

Ind 53.32 DESIGN.

(1) General requirements. Design of plain (non-reinforced) masonry shall be based either on the empirical method and limitations of section Ind 53.322 or on a detailed engineering analysis according to the provisions of section Ind 53.323. Design of reinforced masonry shall be based on the provisions of section Ind 53.323.

(2) Practice. All masonry shall be designed with adequate strength and proportions to support all intended superimposed loads, resist all vertical or horizontal loads as required by this code, and comply with the fire-resistive construction requirements set forth in section Ind 51.04.

Ind 53.321 TYPES OF MASONRY.

(1) Veneer, furring and trim. Veneer, furring and trim comprise a facing of weather-resistant noncombustible materials securely attached to a backing, but not so bonded as to exert common action under load. See section Ind 53.36 for requirements.

(2) Panel wall. A panel wall is composed of weather resisting noncombustible large masonry units, or small masonry units prefabricated into larger assemblages, securely anchored to the framing of the structure.

(3) Single wythe wall. A single wythe wall is one masonry unit in thickness and is built of conventional size masonry units.

(4) Multi-wythe wall. A multi-wythe wall is composed of 2 or more wythes of conventional size masonry units of the same or different materials all tied or bonded together.

(a) Grouted wall. A grouted wall is a multi-wythe wall with all spaces between wythes solidly filled with masonry grout, as defined in section Ind 53.313.

(b) Slushed or parged wall. A slushed or parged wall is a multi-wythe wall with all spaces between wythes nominally filled with mortar.

(c) Hollow wall (includes conventional cavity wall). A hollow wall is a multi-wythe wall with an air space maintained between wythes. A water-repellent or water-resistant insulation may be placed between wythes. The description of a hollow wall is determined by its nominal out-to-out dimension.

(5) Special walls.

(a) Stack or chimney walls. See section Ind 52.10 and Table 53-VIII for general requirements.

(b) Special use walls. See section Ind 53.34 for special requirements.

Ind 53.322 EMPIRICAL METHOD OF DESIGN.

(1) Stresses.

(a) General.

1. In determining the stresses in masonry, the effects of all loads and conditions of loading and the influence of all forces affecting the design and strength of the several parts shall be taken into account.

2. When the effects of eccentricity of vertical loads, including loads produced by the deflection of floor and roof units, are likely to cause tensile stresses in the masonry, the masonry shall be designed in accordance with the requirements of section Ind 53.323.

(b) Allowable stresses.

1. Compressive stresses. The compressive stresses in masonry shall not exceed the values given in Table 53-IX.

2. Bearing stresses. See Ind 53.34 (3) (b).

3. Composite masonry. In composite masonry with different kinds or grades of units or mortars, the maximum stress shall not exceed the allowable stress for the weakest combination of units and mortar of which the masonry is composed.

4. Stone flexural members. The maximum allowable flexural stress for natural stone shall be 1/6 of its modulus of rupture.

5. Bolts and anchors. See Ind 53.34 (5).

TABLE 53-IX

ALLOWABLE COMPRESSIVE STRESSES IN UNIT MASONRY[1]

Type of Masonry	Type of Masonry Units	Average Ultimate Compressive Strength of Masonry Unit[2] (psi)	Allowable Compressive Stresses on Gross Cross-Sectional Area[3] (psi)			
			Type M Mortar and Grout	Type S Mortar and Grout	Type N Mortar and Grout	Type O Mortar and Grout[4]
Single wythe and grouted multi-wythe masonry	Rubble stone	--	140	120	100	80
	Ashlar granite	--	800	720	640	500
	Ashlar limestone and marble	--	500	450	400	325
	Ashlar sandstone and cast stone	--	400	360	320	250
	Solid units except concrete block	10,000 and over	450	400	350	250
		8,000 to 10,000	400	350	300	200
		6,000 to 8,000	300	275	250	175
		4,000 to 6,000	250	225	200	150
		2,500 to 4,000	175	160	140	100
	Solid concrete block	1,800 and over	175	160	140	100
	Hollow load-bearing units	1,000 and over	90	80	75	60
Slushed or parged multi-wythe masonry	All allowable compressive stress values to be 20% less than those for equivalent types of single-wythe and grouted multi-wythe masonry.					
Hollow multi-wythe masonry	Solid units except concrete block	2,500 and over	140	130	110	80
	Solid concrete block	1,800 and over	140	130	110	80
	Hollow load-bearing units	1,000 and over	70	60	55	40

[1]Where a type of masonry unit, mortar or grout is not provided for in Table 53-IX, it will be the practice of the department to allow a maximum compressive stress in the masonry which is no more than 15% of the ultimate compressive strength of a masonry assemblage as determined by an approved test.

[2]No individual masonry unit shall have a compressive strength less than 80% of the average ultimate compressive strength.

[3]Stresses shall be calculated on actual dimensions rather than nominal dimensions, with consideration for reductions such as raked joints and cavities.

[4]Type O mortar is permitted only in certain non-load-bearing masonry. See Table 53-VIII.

(2) Thickness and height.

(a) Height of masonry. The height of a wall is defined for purposes of limitation as the maximum vertical distance between structural members completely supporting the weight of the wall or between the upper such support and the top of the wall, whichever is greater.

(b) Thickness of load-bearing walls. The minimum thickness of load-bearing masonry walls shall be at least 12 inches for the upper 36 feet of their height, and shall be increased 4 inches for the lower 36 feet or fraction thereof. Where a masonry load-bearing wall is made up of 2 or more wythes, the thickness of the wall shall not include any wythe less than 4 inches thick.

EXCEPTIONS TO THICKNESS OF LOAD-BEARING WALLS [Ind 53.322(2)(b)]

1. Stiffened walls. Where single wythe or grouted multi-wythe masonry load-bearing walls composed of units of the same material are laterally supported at distances not greater than 12 feet apart by masonry cross-walls or by reinforced concrete floors, they may be of 12-inch thickness for the whole 72 feet.

2. Top-story walls. Top-story walls may be of 8-inch thickness provided that they are not over 12 feet in height and the roof construction imparts no lateral thrust to the walls.

3. One-story walls. In one-story buildings not exceeding 9 feet in height, the walls may be of 6-inch thickness provided that the roof span does not exceed 18 feet.

4. Penthouses and roof structures. Masonry walls above the main roof level, 12 feet or less in height, enclosing stairways, machinery rooms, shafts or penthouses may be of 8-inch thickness, and may be considered as neither increasing the height nor requiring any increase in the thickness of the masonry below.

5. Walls of apartment buildings. In buildings defined as places of abode (Ind 57.001 (2) not including hospitals) not more than 3 stories in height, walls may be of 8-inch thickness when not over 36 feet in height and the roof imparts no horizontal thrust.

6. Walls below grade. Foundation walls shall be not less than 8 inches in thickness nor less than the thickness of the wall which it supports. When subject to lateral pressures, foundation walls shall be limited to a height over thickness (h/t) ratio of 9 and shall also have lateral support from vertical elements at a spacing required by Table 53-X.

7. Metal tied hollow walls. Hollow walls shall not exceed 36 feet in height. The space (cavity) between wythes shall be not more than 4 inches. The backing wythe shall be at least as thick as the facing wythe. When both the facing and backing wythes have a thickness of 4 inches, the height of such hollow walls shall not exceed 24 feet.

8. Masonry bonded hollow walls. Not allowed.

Note: For definition of hollow walls, see Ind 53.321 (4) (c).

9. Rubble stone walls. All rubble stone walls shall be 4 inches thicker than required in (b) above, but in no case less than 16 inches in thickness. Other exceptions above do not apply to rubble stone walls.

10. Composite walls. Walls containing clay and concrete masonry units shall not exceed 48 feet in height.

(c) Thickness of exterior non-load-bearing walls and parapets. Non-load-bearing exterior masonry walls may be 4 inches less in thickness than required for load-bearing walls [including the exceptions under (b)], but the thickness shall not be less than 8 inches except where 6-inch walls are specifically permitted.

EXCEPTIONS TO THICKNESS OF EXTERIOR NON-LOAD-BEARING WALLS AND PARAPETS [Ind 53.322 (2) (c)].

1. Panel walls. Panel walls shall be designed with sufficient strength and thickness and anchored to the structure so as to insure adequate support and resistance to wind or other lateral forces. Panel walls shall not be less than 2 inches in actual thickness and the maximum ratio of height to thickness shall not exceed 30.

2. Parapet walls. Parapet walls shall not exceed 3 times their thickness in clear height.

(d) Thickness of interior non-load-bearing walls (partitions). Non-load-bearing interior partitions shall be not less than 4 inches in thickness. Where partitions designed for lateral support at the top are not in tight contact with at least a 2-hour fire-resistive construction at the top, such partitions shall be not more than 24 times their thickness in clear height (see Ind 53.322 (3) (a) 3.).

(3) Lateral support.

(a) Requirements. All masonry shall be laterally supported in conformance with the following:

1. Exterior walls. Exterior masonry walls, whether they be load-bearing or non-load-bearing, shall be laterally supported either horizontally or vertically at intervals not exceeding those indicated in Table 53-X.

TABLE 53-X

MAXIMUM RATIO OF LATERALLY UNSUPPORTED HEIGHT OR LENGTH TO THICKNESS FOR ALL EXTERIOR WALLS

Type of Masonry	Mortar Type			
	M	S	N	O
Single wythe walls of solid units or grouted walls of solid units	22	22	20	18
Slushed or parged walls of solid units	20	20	18	16
Hollow walls† or walls containing hollow units	18	18	16	12

†In computing the ratio for hollow walls, the value for thickness shall be the sum of the nominal thickness of the inner and outer wythes.

2. Load-bearing interior walls. Load-bearing interior walls shall have lateral supports at either vertical or horizontal intervals not exceeding 24 times the wall thickness for solid masonry units and 20 times the wall thickness for hollow masonry units.

3. Non-load-bearing interior walls (partitions). Non-load-bearing partitions shall have lateral supports at either vertical or horizontal intervals not exceeding 30 times the thickness of the wall.

4. Special masonry walls. Exterior masonry walls having no lateral support at the top or at the ends (free standing), shall have their height limited to 4 times their thickness. (See Ind 53.322 (2) (c) 2. for parapet walls.) Similar interior walls (free standing), shall have their height limited to 6 times their thickness.

(b) Methods of lateral support.

1. General. Lateral support shall be provided by cross walls, pilasters or vertical structural members of sufficient strength to provide the required support when the limiting distance is measured horizontally; and/or by floors, roofs or horizontal structural elements which are of sufficient strength to provide the required support when the limiting distance is measured vertically. Provisions shall be made to transfer all lateral forces to the foundation.

2. Limitations. When horizontal structural elements are depended upon for lateral support, lateral support by vertical elements shall also be provided at intervals of not more than 72 times the wall thickness.

(c) Pilasters. A pilaster is a reinforced or nonreinforced masonry section which is thicker than and integrally bonded or mechanically keyed to the adjoining wall by alternate course bonding of masonry or by the use of pilaster blocks. A mechanically keyed control joint will be permitted on only one side of a pilaster which is used to provide lateral support. The projecting portion of the pilaster shall be bonded to the wall portion of the pilaster by lapping at least 50% of the units at the intersection or using special pilaster units.

1. All pilasters relied upon to provide lateral support shall not be less than 4 inches thicker than the wall supported nor less than 1/12 times the pilaster height. The width of pilasters shall be not less than 16 inches.

2. Where a pilaster is needed to carry a concentrated load from a flexural element, the least dimension shall be not less than 1/40 of the span of such an element and the height of the pilaster shall not exceed 12 times the least dimension of the pilaster.

(d) Piers. A pier is an isolated column of masonry. A load-bearing wall not bonded at the sides into associated masonry shall be considered a pier when its horizontal dimension measured at right angles to the thickness does not exceed 4 times its thickness.

1. All piers shall have lateral supports so that the vertical distance between such supports does not exceed 10 times their least dimension for single wythe or grouted masonry walls of solid masonry units, 8 times their least dimension for slushed or parged masonry walls of solid masonry units, and 6 times their least dimension for other masonry.

2. The least dimension of piers carrying flexural members shall be not less than 1/30 of the span of the flexural members.

3. Piers shall be laid in running bond unless reinforced as required for stack bond walls.

(4) Openings. Unless evidence is provided to show that openings do not cause lateral stability and stress requirements to be exceeded, the amount of openings in a masonry wall shall not exceed the limits set forth in Table 53-XI.

TABLE 53-XI

MAXIMUM RATIO OF LATERALLY UNSUPPORTED HEIGHT OR LENGTH TO THICKNESS FOR EXTERIOR WALLS WITH OPENINGS†

Type of Masonry	Percent of Openings at any Horizontal Plane of Wall			
	20	40	60	Over 60
Single wythe walls of solid units or grouted walls of solid units	20	16	12	Submit design calculations
All other masonry	18	14	10	

†The percentage of openings shall be calculated for each 100 lineal feet of wall or portion thereof at any horizontal plane of wall. See Table 53-X for additional restrictions when type "N" or "O" mortar is used.

(5) Bonding.

(a) General. All types of masonry shall be adequately bonded.

(b) Longitudinal bond.

1. Running bond. In each wythe of masonry, not less than 60% of the units in any transverse vertical plane shall lap the ends of units above and below a distance not less than 2 inches or 1/3 the height of the unit, whichever is greater. Masonry not lapped as required above will be considered as stack bond and shall be reinforced longitudinally as required in 2. below for masonry units laid in stack bond.

2. Stack bond. In each wythe of masonry with units laid in stack bond, the masonry shall be reinforced by a continuous tie assembly, as defined in Ind 53.316 (2), at vertical intervals not exceeding 16 inches. For interior non-load-bearing partitions this spacing may be increased to 24 inches. (For load-bearing walls, see also Ind 53.34 (3) (b) 4.)

3. Single wythe exterior concrete masonry walls. When units are laid in running bond, such masonry walls shall be reinforced by a continuous tie assembly, as defined in Ind 53.316 (2), at vertical intervals not exceeding 24 inches.

(c) Transverse bond. In multi-wythe masonry, adjacent wythes shall be bonded with either metal ties or headers in accordance with the following:

1. Bonding with metal ties. Adjacent wythes of masonry shall be bonded by embedment of reinforcement in the horizontal mortar joints with one of the following methods:

   a. Continuous tie assemblies, as defined in Ind 53.316 (2), spaced at vertical intervals not exceeding 16 inches.

   b. Individual ties, the equivalent of not less than 3/16 inch diameter steel rods, with one tie for not more than each 4-1/2 square feet of wall area. Ties in alternate courses shall be staggered. The maximum vertical distance shall not exceed 18 inches. The maximum horizontal distance shall not exceed 36 inches. Ties bent to rectangular shape shall be used with hollow masonry units. With solid masonry units, either rectangular ties or ties bent to 90 degree angles, Z shaped, to provide hooks not less than 2 inches long shall be used. In hollow walls, additional ties shall be provided at all openings, spaced not more than 3 feet apart around the perimeter and within 12 inches of the opening.

2. Bonding with masonry bond units (headers).

   a. Adjacent wythes of masonry shall be bonded by the equivalent of a full header course overlapping both wythes at least 3 inches and spaced at intervals not greater than every seventh course. The clear distance between bond courses shall not exceed 16 inches for solid units and 24 inches for hollow units. One-seventh of the wall surface shall be header or bond units.

   b. In ashlar masonry, bond stones uniformly distributed shall be provided to the extent of not less than 10% of the area of exposed faces.

c. Rubble stone masonry shall have not less than one bond stone for each 6 square feet of wall surface on both sides. Such walls, 24 inches or less in thickness, shall have bond stones with a maximum spacing of 3 feet vertically and 3 feet horizontally.

d. Hollow walls shall not be bonded with headers.

Note: For definition of hollow walls, see Ind 53.321 (4) (c).

3. Interrupted bond. Where a structural member interrupts a backing wythe such that transverse bond otherwise required cannot be achieved, the facing wythe shall be bonded to that structural member as in 1. above.

(d) Bond at intersections and corners. Masonry that changes direction, or meets or intersects other masonry, where dependent for lateral support, shall be bonded by one of the following methods:

1. Walls laid separately. Provide joints with not less than the following:

a. For load-bearing elements, the equivalent of 1-1/4 inch by 1/4 inch anchors with ends turned up not less than 2 inches and not less than 24 inches between turned ends, embedded equally into each adjacent wall and spaced not more than 2 feet vertically. Where there is not sufficient thickness of masonry to embed such anchors properly, equivalent anchorage shall be provided by cross-pins or other means.

b. For non-load-bearing elements, the equivalent of 7/8 inch by 22 U.S. gage anchors, 8 inches or more in length, embedded equally into each adjacent wall and spaced not more than 16 inches vertically.

c. When regularly toothed or blocked, the vertical spacing of anchors required above may be doubled.

2. Walls laid simultaneously. Provide joints satisfying one of the following:

a. Lap at least 50% of the units at the intersection.

b. Use details which are designed to permit differential movement at the intersection of interior and exterior masonry, provided such details are consistent with the requirements for lateral stability of the masonry.

(6) Anchorage.

(a) General. All masonry dependent upon structural elements for continuity or lateral support shall be securely anchored thereto in such a manner as to resist all forces, especially wind and all lateral forces acting either inward or outward.

(b) Load-bearing masonry.

1. Floor anchorage.

a. All types of concrete floor systems which bear continuously on masonry with concrete to masonry contact may be considered to provide adequate lateral support.

b. All other structural elements intended to provide lateral support shall be securely anchored to the masonry.

2. Roof anchorage. Roof structures shall be securely anchored to load-bearing masonry with the equivalent of at least 1/2-inch diameter bolts spaced not more than 6 feet on center and embedded in the masonry according to one of the following methods:

a. A steel plate having a minimum surface area of 6 square inches securely attached to the head of each bolt and completely embedded in the masonry at least 12 inches.

b. A continuous bond beam the equivalent of not less than 8-inch lintel (bond beam) blocks with 2 continuous No. 4 bars embedded in 2,500 psi concrete fill provided at the top of the masonry. The bolts shall be embedded at least 6 inches and hook beneath the longitudinal reinforcement.

(c) Exterior non-load-bearing masonry.

1. Anchorage of masonry to the structural framework. Where masonry is dependent upon the structural framework for lateral support or transmission of lateral loads, such masonry shall be anchored on at least 2 opposite sides of its perimeter to the framework, with the equivalent of a one-inch wide by 1/8-inch thick anchor for each 12 square feet of wall surface, embedded at least 8 inches into the masonry, and spaced not more than 36 inches on center. Wedging will not be considered as an equivalent method.

2. Anchorage of panel walls suspended from the structural framework. Exterior prefabricated masonry assemblages and other elements larger than conventional size masonry units shall be anchored to their weight supports with the equivalent of 5/8 inch minimum diameter stainless steel bolts or 3/4 inch minimum diameter corrosion resistant plated steel bolts.

(d) Interior non-load-bearing masonry. Where masonry is dependent upon the structural framework for lateral support, such masonry shall be anchored with the equivalent of a flexible 3/16 inch diameter anchor for each 12 square feet of wall surface, embedded at least 4 inches into the masonry, and spaced not more than 48 inches on center. Wedging may be used to anchor the top of a masonry partition to its top horizontal support.

(7) Jointing. Joints commensurate with lateral stability requirements shall be installed in all exterior masonry to allow for expected growth of clay products and shrinkage of concrete products.

(a) Vertical jointing. Vertical control joints shall be provided at a spacing in compliance with Table 53-XII.

Note: To accomplish the intended purpose, joints should be located at critical locations such as (but not limited to) changes in building heights, changes in framing systems, columns built into exterior walls, major wall openings and changes in materials.

TABLE 53-XII

MAXIMUM SPACING OF EXTERIOR MASONRY CONTROL JOINTS BETWEEN UNRESTRAINED ENDS† (FEET)

Loading Conditions	Type of Material	Openings (Percentage of total wall area)			
		0 to 20		More than 20	
		Joint to Joint	Joint to Corner	Joint to Joint	Joint to Corner
Load-bearing	Clay units	140	70	100	50
	Concrete units	60	30	40	20
Non-load-bearing walls	Clay units	100	50	60	40
	Concrete units	50	25	30	20

†Jointing required is a minimum and is not intended to prevent minor cracking. The distances given for maximum spacing of joints are for a single wall plane. For composite walls, the maximum spacing of joints shall be governed by the masonry material type used in the exterior wythe.

(b) Horizontal jointing. Where supports such as shelf angles or plates are required to carry the weight of masonry above the foundation level [see Ind 53.322 (2) (a) and Ind 53.36 (4) (b)], a pressure-relieving joint shall be provided between the structural support and any masonry which occurs below this level. The joint width shall be such as to prevent any load being transmitted from the support to any element directly below. All mortar and rigid materials shall be kept out of this joint. This type of joint shall be provided at all such supports in a concrete frame structure where clay masonry is exposed to the weather.

Ind 53.323 ENGINEERED MASONRY.

(1) Definition. Engineered masonry means design of plain or reinforced masonry based on an engineering analysis.

(2) Requirements. Calculations or other substantiating data to justify a reduction in requirements shall be submitted for all items in conflict with sections Ind 53.322, 53.33 or 53.34.

Note: It will be the practice of the department to approve designs in conformance with the following: (1) clay and shale units - "Building Code Requirements for Engineered Brick Masonry," Structural Clay Products Institute (now known as Brick Institute of America), 1750 Old Meadow Road, McLean, Virginia 22101 (August 1969); (2) concrete units - "Specifications for the Design and Construction of Load-Bearing Concrete Masonry," National Concrete Masonry Association, P. O. Box 9185, Rosslyn Station, Arlington, Virginia 22209 (1970); (3) cast stone and architectural precast concrete units - "Design of Precast Concrete Wall Panels," Title No. 68-46, ACI Journal, July 1971 (also see section Ind 53.40); and (4) standards of accepted engineering practice, provided proposed materials are in successful similar use or proven by test to be adequate.

(3) Limitations. Where design by engineering analysis is based upon material of a higher grade or a superior workmanship than is generally provided in accepted practice, it must be clearly established to the satisfaction of the department by test or other evidence that such quality exists and will only be employed under special inspection or field testing.

Ind 53.33 CONSTRUCTION.

(1) Precautions. See the requirements of Wis. Adm. Code Chapter Ind 35--Safety in Construction.

(2) Cold weather work. Adequate cold weather construction and protection provisions shall be taken to prevent masonry from being damaged by freezing.

Note: It will be the practice of the department to accept conformance with "Recommended Practices for Cold Weather Masonry Construction," International Masonry Industry All-Weather Council, 1970. (Available from International Masonry Institute, 823 15th Street NW, Washington, D. C. 20005.)

(3) Workmanship for load-bearing masonry.

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

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

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

(4) Cleaning. Chemical cleaning agents shall be prevented from harming the metal reinforcement of structural components.

Ind 53.34 MISCELLANEOUS DESIGN-CONSTRUCTION DETAILS.

(1) Special use walls.

(a) Hollow walls.

1. In exterior hollow walls, suitable flashing shall be installed at the bottom of the cavity so as to drain any water outward.

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

(b) Parapet walls.

1. See Ind 51.02 (12) for requirements of parapet walls.

2. When roof drains are needed to remove precipitation and are the sole means of water escape, there shall be placed in all parapet walls scuppers or relief openings to prevent overloading of the roof.

(c) Retaining walls. The tops of exposed retaining walls shall be coped with noncombustible weatherproof material.

(d) Reuse of existing walls. Existing masonry may be used in the alteration of extension of a structure, provided that under the new conditions imposed it meets the requirements of this code or is made so by reasonable repairs.

(2) Changes in thickness or plane.

(a) Nonvertical planes. Details and techniques for all masonry to be installed in a nonvertical plane shall be submitted to the department for approval.

(b) Thickness change requirements. Where hollow walls or walls of hollow masonry units change in thickness, a course of solid masonry, concrete-filled hollow units or a continuous bearing element shall be interposed between the thicker and thinner sections.

(c) Increase in thickness, including corbels. The thickness of masonry shall not be increased (in the upward direction), except for corbels as follows:

1. The maximum horizontal projection of a corbel from the face of the wall from which it projects shall not exceed 1/3 the thickness of the wall.

2. The maximum projection of a masonry unit shall not exceed 1/2 the height of the unit nor 1/3 its bed depth.

(d) Variation in thickness (chases and recesses). Walls shall not be less than their required thickness between horizontal lateral supports except where permitted for chases and recesses as follows:

1. Chases or recesses shall not be made in load-bearing walls 8 inches or less in thickness. Pipes, ducts, conduits or similar noncombustible items may be installed in cores of hollow units.

2. Chases or recesses shall not be closer than 2 feet to any pilaster, buttress, cross wall, end wall or other stiffener that provides lateral support.

3. The maximum depth of any chase or recess shall not exceed 1/3 the thickness of the wall.

4. The length along the wall of any chase or recess shall not exceed 4 feet.

5. The clear distance between chases and recesses or each other shall not be less than 4 times the wall thickness.

6. Any chase or recess in conflict with the previous requirements shall be considered as an opening (see Ind 53.34 (3) (a) 4.).

7. No chase or recess shall reduce the thickness of material below the minimum required for fire walls, fire division, fire partitions or fire protective covering of structural members.

(e) Protection. In masonry exposed to the weather, pockets or crevices in which water may accumulate shall be avoided or protected to prevent damage.

(3) Bearing.

(a) Weight support of masonry.

1. General requirements. The bearing support for all masonry shall be of noncombustible material and have lateral stability.

2. Projections. The projection of a wall beyond the edge of a supporting member other than masonry, such as a shelf angle or edge of a beam, shall not exceed 1-1/4 inches, unless at least 2/3 the mass of the wythe of masonry involved is located directly over the load-carrying member.

3. Shelf angles. See Ind 53.322 (7) (b).

4. Openings. The masonry above openings shall be adequately supported. The bearing length of structural elements which support the masonry above the opening shall be not less than 4 inches. The bearing stresses at these locations shall not exceed those allowed in Ind 53.322 (1).

(b) Bearing on masonry. Bearing stresses in masonry shall not exceed those specified in Ind 53.322 (1). Flexural members shall have bearing details that allow rotation at their supports without causing local failures.

1. Concentrated loads. Beams, girders, trusses, joists and other members causing concentrated loads shall bear a minimum of 3 inches in length in the direction of span upon at least one of the following:

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

b. Solid masonry. At least 8 inches in height of masonry composed of solid units.

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

d. Bond beam. The bond beam shall be the equivalent of not less than 8-inch lintel (bond beam) blocks with 2 No. 4 bars embedded in 2,500 psi concrete fill. The loads shall bear on the concrete fill.

2. Continuous loads. Joists, trusses and beams other than wood [for wood, see Ind 53.63 (4)], spaced 4 feet or less on center and 40 feet in span, slabs or other members causing continuous loads shall be transmitted to masonry with a minimum bearing length of 3 inches upon solid masonry at least 2-1/2 inches in height, or as indicated for concentrated loads.

3. Multi-wythe walls. Ties required for transverse bond shall be installed in the first horizontal mortar joint below the required beam, solid masonry or metal plate.

4. Stack bond walls. Concentrated loads shall be distributed into masonry laid in stack bond by a concrete beam or bond beam (as defined in 1. above). For masonry of solid units, 2 additional rows of a continuous tie assembly [as defined in Ind 53.316 (2)] may be used instead of a concrete beam or bond beam.

5. Support of wood floor members.

a. Where a wood structural member is buried in masonry for support, it shall be fireout or a self releasing device shall be used.

b. Where the end of a wood structural member is built into an exterior wall, a 1/2-inch air space shall be provided at the sides, top and end of such member.

(4) Jointing. See Ind 53.322 (7) for jointing.

(5) Bolts and anchors. The allowable shear on steel bolts and anchors shall not exceed the values given in Table 53-XIII.

TABLE 53-XIII

ALLOWABLE SHEAR ON BOLTS AND ANCHORS

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

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

Ind 53.35 TESTS

(1) General. All masonry materials shall meet the requirements of section Ind 53.31, and the department may require submittal of test data, at any time, to show conformity.

(2) Sampling and testing. The selection and construction of all test specimens shall conform to standard test procedures and shall be truly representative of the materials, workmanship and details to be normally applied in practice.

(3) Standards. The testing of all masonry shall be in accordance with Table 53-XIV.

TABLE 53-XIV

STANDARD METHODS OF SAMPLING AND TESTING

Classification	Item	ASTM Test Method Including Ind 51.25 (No.)
Base Materials	Portland Cement	C 150(31)
	Masonry Cement	C 91(22)
	Hydrated Lime	C 25(10), C 50(14), C110(25)
	Gypsum	C 471(37), C 472(38)
	Aggregate	C 144(29)
Mortar	Mortar	C 270†(34)
Masonry Units	Clay and Shale	C 67(20), C 112(26)
	Concrete	C 140††(28)
	Natural Stone	C 97(23), C 99(24), C 170(32), C 666(42)
	Cast Stone	C 42(13), C 97(23)
	Arch. Precast Concrete	C 39(12), C 42(13), C 97(23), C 457(36)
	Gypsum	C 473(39)
Assemblies		E 72(46), E 149(51), E 447(54)

†Mortar in the field, tested in a laboratory, shall test at least 85% of the minimum compressive strength required, and the field mortar will serve as the final basis for mortar approval. When mortar is not proportioned according to limitations of Table 53-VII, mortar shall be periodically tested by an impartial testing laboratory. Results of such required testing shall be submitted as evidence of conformity, when requested by the department.

††Typical hollow load-bearing concrete masonry units shall be initially tested for compliance; thereafter periodic testing may be required as directed by the department. Sampling shall be done only by the department or its authorized agents. The time and place of sampling will be at the discretion of the department.

Note: A record of initial test and subsequent spot checks will be kept by the department.

(4) Special tests.

(a) Fire tests. See section Ind 51.04.

(b) Load tests. Whenever there is reasonable doubt as to the stability or structural safety of a completed structure or part thereof, the department may require a load test on the building or portion of the structure in question.

Ind 53.36 VENEER, FURRING AND TRIM.

(1) General. Veneer, furring and trim as used in this section refers to a facing of weather-resistant noncombustible materials securely attached to a backing, but not so bonded as to exert common action under load.

(a) Veneer shall not be considered as part of the masonry when computing strength or required thickness.

(b) Veneer shall not be assumed as supporting any load other than its own weight.

(2) Material requirements.

(a) General. See section Ind 53.31 for typical requirements of common masonry materials.

(b) Tile and terra-cotta. Such units shall be frost-proof and not more than 288 square inches in area.

(3) Thickness. No materials used for veneer shall have a thickness less than the values listed in Table 53-XV.

TABLE 53-XV

MINIMUM THICKNESS OF VENEERS

Material	Minimum Actual Thickness (Inches)
Clay Brick or Tile	1-5/8
Concrete Masonry Units	1-5/8
Natural Stone	1-5/8
Cast Stone	1-1/2
Architectural Precast Concrete	5/8
Marble Slabs	7/8
Slate	7/8
Architectural Terra-cotta	1
Ceramic Veneer--Mechanical Anchorage	1
Ceramic Veneer--Adhesion Anchorage	3/16
Asbestos Cement Boards	1/8
Aluminum Clapboard Siding	.024
Metal--Corrosion Resistant	.0149
Stucco and Exterior Plaster	3/4

(4) Bearing and backing supports.

(a) Bearing and backing supports shall be weather-resistant and shall provide sufficient strength and stability to adequately support the veneer.

(b) Masonry veneer 1-5/8 inches or greater in thickness shall be supported by shelf angles or other equivalent weight supports. The spacing between such supports shall not exceed 18 feet vertically when the veneer is more than 30 feet above grade.

(5) Attachment.

(a) General. All veneers, supports and attachments shall be capable of resisting a horizontal force equal to the wind loads specified in section Ind 53.12. Attachment shall be accomplished by mechanical methods or adhesion.

(b) Attachment by mechanical methods. All anchors shall be corrosion-resistant.

1. Veneer of conventional size masonry units (one square foot or less). Such veneer shall be securely attached to its backing by anchors the equivalent of 22 U.S. gage corrugated sheet steel 7/8 inch wide with at least one such tie located in every 2 square feet of wall.

2. Veneer of large size masonry units (greater than one square foot). Such veneer shall be securely attached with anchors the equivalent of not less than 1/4 inch diameter bolts in accordance with either of the following:

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

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

3. Veneer of metal. Exterior metal veneer shall be securely attached to its backing or supporting framework with the equivalent of wire of at at least No. 9 steel wire gage spaced not more than 24 inches apart both horizontally and vertically. Wider spacing where proved adequate may be used when units exceed 4 square feet in area, provided there are at least 4 proper attachments per unit.

(c) Attachment by adhesion. Veneer one inch or less in thickness may be cemented to a masonry or concrete wall or to exterior portland cement plaster on high rib galvanized metal lath with an adhesive, provided that the bond is sufficient to withstand a shearing stress of 50 psi after curing for 28 days. Individual units so attached shall not exceed 30 inches in any one dimension nor have more than 540 square inches of face area.

(6) Jointing. Pressure-relieving joints commensurate with lateral stability requirements shall be provided both horizontally and vertically where needed to compensate for differential movement between veneer and backing or frame. See also Ind 53.322 (7).

(7) Grounding. Metal veneers fastened to supporting elements which are not a part of the grounded metal framing of a building shall be effectively grounded.

CONCRETE

Ind 53.40 CONRETE REQUIREMENTS.

(1) General. The design and construction of structures in concrete of cast-in-place or precast construction, plain, reinforced or prestressed shall conform to the rules and principles of the following standards:

(a) ACI Std. 318 [Ind 51.26(1)], Building Code Requirements for Reinforced Concrete.

(b) ACI Std. 512 [Ind 51.26(2)], Recommended Practice for Manufactured Reinforced Concrete Floor and Roof Units.

(c) ACI Std. 525 [Ind 51.26(3)], Minimum Requirements for Thin Section Precast Concrete Construction.

Note: The following standards (1) through (12) are recognized by the department as being good engineering practice: (1) "Commentary on Building Code Requirements for Reinforced Concrete," ACI Report 318; (2) "Recommended Practice for Selecting Proportions for Concrete," ACI Std. 211.1; (3) "Recommended Practice for Selecting Proportions for Structural Lightweight Concrete," ACI Std. 211.2; (4) "Recommended Practice for Hot Weather Concreting," ACI Std. 605; (5) "Recommended Practice for Cold Weather Concreting," ACI Std. 306; (6) "Manual of Standard Practice for Detailing Reinforced Concrete Structures," ACI Std. 315; (7) "Recommended Practice for Evaluation of Compression Test Results of Field Concrete," ACI Std. 214; (8) "Recommended Practice for Measuring, Mixing and Placing Concrete," ACI Std. 614; (9) "Recommended Practice for Concrete Formwork," ACI Std. 347; (10) "Specification for the Design and Construction of Reinforced Concrete Chimneys," ACI Std. 505; (11) "Suggested Design of Joints and Connections in Precast Structural Concrete," ACI Report 512 (Copies of above standards may be obtained from American Concrete Institute, P. O. Box 4754, Redford Station, Detroit, Michigan 48219); (12) "Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction," AWS Std. 12.1 (American Welding Society, 2501 NW 7th St., Miami, Florida 33125).

Ind 53.41 GYPSUM CONCRETE REQUIREMENTS.

(1) General. The design and construction of gypsum concrete shall be in accordance with the following standards:

(a) ASTM C 317 [Ind 51.25(35)], Standard Specifications for Gypsum Concrete.

(b) ANSI A 59.1 [Ind 51.27(5)], Specifications for Reinforced Gypsum Concrete.

(2) Limitations. Gypsum concrete shall not be used where exposed directly to weather or where subject to wetting. Gypsum concrete shall be protected from freezing or coming in contact with moisture during shipment, storage, erection or pouring.

Ind 53.42 VERMICULITE CONCRETE REQUIREMENTS. Vermiculite concrete, when used in roof systems and slabs-on-grade, shall be in accordance with: ANSI A 122.1 [Ind 51.27(5)], "Specifications for Vermiculite Concrete Roofs and Slabs-on-Grade." Vermiculite concrete shall not be used where it can be subjected to moisture.

METALS

Ind 53.50 STRUCTURAL STEEL REQUIREMENTS. The design, fabrication and erection of structural steel for buildings and structures shall conform to: AISC [Ind 51.27 (2)], "Specification for Design, Fabrication and Erection of Structural Steel for Buildings," and the provisions of the accompanying commentary for this specification, with the following modifications:

(1) Fabricator splices. Any shop or field connection or splice not specifically shown on the designer's drawings shall have been previously approved by the designer and a record shall be kept of this approval. This record shall be submitted to the department when requested.

(2) Lateral bracing members. Individual bracing members providing lateral restraint to columns or to compression flanges of beams and girders or to compression chords of trusses shall be proportioned to resist at least 2 percent of the compression force at the brace location unless a suitable analysis is made to determine the appropriate strength and stiffness of the bracing member.

(3) Certification and identification.

(a) Certification. All structural steel shall have a mill report or a test report made in accordance with ASTM A-6 [Ind 51.25(1)] from the steel supplier; the reports shall include the information on the minimum yield strength and chemistry of the steel furnished. Upon request by the department, the supplier or fabricator shall furnish certified mill reports, test reports, affidavits and/or other information about the steel for the specific project.

(b) Marking of steel. Steel used for main components in completed members or assemblies shall be marked. This marking shall be accomplished by color coding or other means of identification as to its type or grade† prior to shipment from the mill. The marking shall be continued through the fabricator's plant to the construction site. Steel which conforms to ASTM A-36 [Ind 51.25(2)] designation may be fabricated without marking.

†Note: The type and grading may be indicated by the ASTM specification

designation or a designation correlated to the information included on the certified mill or test report.

(c) Acceptable steel types. Steel of structural quality shall conform to the standards specified in section 1.4.1.1 of the AISC [Ind 51.27 (2)]. Steel types not listed in the above mentioned section of the AISC may be used if approved by the designer. An approval letter indicating conformance with Ind 53.50 (a) and (b) shall be sent to the department.

Ind 53.51 COLD-FORMED STEEL REQUIREMENTS. The design of cold-formed steel for buildings and structures shall conform to the AISI [Ind 51.27 (4)] "Specification for the Design of Cold-Formed Steel Structural Members," and the provisions of the accompanying commentary for this specification, with the following modifications:

(1) Fabricator splices. See Ind 53.50 (1).

(2) Lateral bracing members. See Ind 53.50 (2).

(3) Certification. See Ind 53.50 (3) (a).

Ind 53.52 STEEL JOIST REQUIREMENTS. The design, fabrication and erection of steel joists shall conform to the "Standard Specifications for: Open Web Steel Joists, Longspan Steel Joists and Deep Longspan Steel Joists" adopted by the SJI [Ind 51.27 (9)].

Ind 53.53 STRUCTURAL WELDING OF STEEL. The requirements of this section shall apply to all welds on or between materials within the scope of Ind 53.50, Ind 53.51 and Ind 53.52.

(1) Base metals. Steels to be welded under this code are listed in AWS D 1.1, sections 8.2 and 10.2 [Ind 51.27 (6)].

(2) Filler metals. Filler metal requirements that are acceptable under this code are listed in AWS D 1.1, section 4.1 [Ind 51.27 (6)].

(3) Welding processes.

(a) Manual shielded metal arc, submerged arc, gas metal arc and flux cored arc welding processes conforming with the procedures established in AWS D 1.1, sections 2, 3 or 4 [Ind 51.27 (6)] shall be considered as prequalified and are approved for use without performing procedure qualification tests.

(b) Electroslag and electrogas welding processes will not be considered as prequalified. They may be used provided a procedure is developed and provided it conforms to the applicable provisions of AWS D 1.1, sections 2, 3 or 4 [Ind 51.27 (6)].

(4) Welding procedures.

(a) Procedure specification. All welding procedures shall be prepared as a written procedure specification. This written procedure specification shall be prepared by the manufacturer, fabricator or contractor and shall be made available or submitted to the department when requested.

Note: Suggested form SB-223A, showing the information required in the procedure specification, may be obtained from the department.

(b) Procedure qualification. All joint welding procedures shall be previously qualified by tests as prescribed in AWS D 1.1, section 5.6 [Ind 51.27(6)], except for the prequalified procedures exempted in Ind 53.53(3)(a). The test shall be conducted under the supervision of an approved testing laboratory and the test results shall be submitted to the department for approval.

(5) Design of welded connections and joints. The details of all joints shall comply with the requirements of AWS D 1.1, section 2 and section 10, parts III and IV [Ind 51.27(6)]. A joint form not specified in AWS D 1.1, section 2 and section 10, parts III and IV, shall not be used until it is qualified to the satisfaction of the department.

(a) Stud welding. Stud welding shall be done by a procedure qualified in accordance with the requirements of AWS D 1.1, section 4, part VI [Ind 51.27(6)].

(6) Operator qualifications. All structural welding work shall be done by certified [as defined in Ind 53.53(7)] welders. The required qualification test shall be conducted under the supervision of an approved testing laboratory. The weld test report shall be submitted to the department for evaluation. Test specimens shall be submitted when requested by the department.

(a) The manual welders shall be tested and qualified in accordance with AWS D 1.1, section 5, part III [Ind 51.27(6)].

(b) The manual tackers shall be tested and qualified in accordance with AWS D 1.1, section 5, part V [Ind 51.27(6)].

(c) The welding machine operator shall be tested and qualified in accordance with AWS D 1.1, section 5, part IV [Ind 51.27(6)].

(7) Operator certification. The department will issue to the operator who has successfully passed prescribed qualification tests, a certificate bearing his name, social security number, identifying mark, the process, the procedure specification number and other pertinent information from his qualification test. This certificate will remain in effect for one year provided the operator is continuously engaged in welding operations without an interruption of more than 3 consecutive months. If the interruption exceeds 3 consecutive months, the certificate shall automatically become void.

Note: See Wis. Adm. Code Chapter 69, Fee Schedule, for issuance of certificate SB-13.

(a) The annual renewal of a certificate shall be granted upon the submittal of documentary evidence stating that the welder has been continuously employed in welding operations or by testing.

(b) Each manual welder and tacker or machine operator shall be retested every 3 years in accordance with Ind 53.53(6).

(8) Weld identification. Each structurally significant member shall have its welding identified by a distinguishing mark stamped on the member by the certified welders involved.

(9) Criterion of final acceptance. All structural welding is subject to examination by approved inspectors and such inspection shall be the final criterion for conformance and acceptability for the intended use.

(10) Structural welding done outside the state of Wisconsin. All welding shall conform with the requirements of section Ind 53.53. In addition, manufacturers and suppliers of structural steel shall, prior to commencing any welded construction, submit evidence of procedure qualification and welder certification that has been approved by an independent testing laboratory which is acceptable to the department.

Ind 53.54 ALUMINUM FRAMING REQUIREMENTS. The design, fabrication and erection of aluminum structural framing members shall conform to "Specifications for Aluminum Structures" [Ind 51.27 (1)], published by The Aluminum Association.

Ind 53.55 STAINLESS STEEL REQUIREMENTS. The design, fabrication and erection of light gage stainless steel framing members shall conform to AISI [Ind 51.27 (4)], "Specification for the Design of Light Gage, Cold-Formed Stainless Steel Structural Members."

Ind 53.56 OTHER METALS. The design, fabrication and erection of other metals or metal alloys not specifically listed in this section shall be in accordance with the provisions of section Ind 50.12.

WOOD AND WOOD FIBER PRODUCTS

Ind 53.60 GENERAL.

(1) Scope. The requirements of sections Ind 53.60 to 53.63, inclusive, shall apply to the materials, design, and construction procedures used in all wood and wood fiber products construction work under this code.

(2) Definition. Wood and wood fiber products include those structural elements derived from solid wood, structural glued-laminated timber, plywood, fiberboard, hardboard and other wood-fiber-based materials.

Ind 53.61 MATERIALS AND DESIGN OF STRUCTURAL ELEMENTS.

(1) Sawn lumber. The material characteristics and the design provisions of load-bearing structural sawn lumber shall be in accordance with the following adopted standard and listed exceptions:

(a) "National Design Specifications for Stress-Grade Lumber and Its Fastenings" [Ind 51.27 (8)] and its Supplement Table 1, including Tables 1a and 1b.

1. Exceptions:

a. Section 200-B-1. The provisions of this section shall also apply to reused lumber. Reused lumber shall be considered to have a duration of load factor of 0.90.

b. Section 200-G-1. In addition to requiring grading in conformance with ASTM D 245 [Ind 51.25 (43)], lumber (including reused lumber) of species and grades not listed in Table 1 of the supplement to the NDS [Ind 51.27 (8)] shall be identified by the grade mark of, or certificate of inspection issued by, a lumber grading or inspection bureau or agency recognized as being competent.

c. Section 203-A. The cumulative effects of short-time loads, such as snow, shall be considered in determining duration of load. For snow load, no greater duration of load factor than 1.05 shall be used.

d. Section 102-D. Refer to section Ind 53.11. The combination of full snow load with wind load shall be taken into consideration.

e. Part IX is deleted. Refer to section Ind 53.61 (2).

(2) Structural glued-laminated timber. Structural glued-laminated timber is an engineered, stress-rated product of a timber laminating plant comprising assemblies of specially selected and prepared wood laminations securely bonded together with adhesives. The grain of all laminations is approximately parallel longitudinally. The following standards are adopted as part of this building code for the design and production of structural glued-laminated timber:

(a) AITC 117 [Ind 51.27 (3)], "Standard Specifications for Structural Glued-Laminated Timber of Douglas Fir, Western Larch, Southern Pine and California Redwood."

(b) AITC 119 [Ind 51.27 (3)], "Standard Specifications for Hardwood Glued-Laminated Timber."

(c) AITC 120 [Ind 51.27 (3)], "Standard Specifications for Structural Glued-Laminated Timber Using 'E' Rated and Visually Graded Lumber of Douglas Fir, Southern Pine, Hem Fir and Lodgepole Pine."

(3) Round poles. Allowable unit stresses for nongraded round poles used as structural members other than piling shall be 80 percent of the allowable unit stresses for select structural grade beams and stringers (19 percent moisture content) of the appropriate species as listed in Table 1, supplement to the National Design Specification for Stress Grade Lumber and Its Fastenings [Ind 51.27 (8)]. No obviously unsound load-bearing poles are to be used. Higher allowable stresses will be permitted for round poles graded in accordance with a recognized standard.

Note: ASTM designation D 3200-73 "Standard Specification and Methods for Establishing Recommended Design Stresses for Round Timber Construction Poles" is acceptable for graded round poles. ANSI Standard 05.1-1972 may be used for poles subject to transverse loads only.

(4) Piling. See section Ind 53.24.

(5) Plywood.

(a) General. The quality and design of all plywood used in construction of all buildings and structures shall conform to the minimum standards under

this section. All plywood when used structurally, including among others, use for siding, roof and wall sheathing, subflooring, diaphragms, and built-up members, shall conform to the performance standards for its type in U.S. Product Standard PS 1 [Ind 51.27 (11)] for softwood plywood/construction and industrial. Each panel or member shall be identified for grade and glue type by the trademarks of an approved testing and grading agency. In addition, all plywood when permanently exposed in outdoor applications shall be of exterior type.

Note: It will be the policy of the department to approve designs in conformance with the following: (1) "Plywood Design Specification," including Supplement No. 1, "Design of Plywood Curved Panels"; Supplement No. 2, "Design of Plywood Beams"; Supplement No. 3, "Design of Flat Plywood Stressed-Skin Panels"; and Supplement No. 4, "Design of Flat Plywood Sandwich Panels"; (2) "Plywood Diaphragm Construction"; (3) Laboratory Report 121, "Plywood Folded Plate Design and Details"; (4) Laboratory Report 93, "Load-Bearing Plywood Sandwich Panels"; and (5) "Fabrication Specifications Plywood-Lumber Components: CP-8, BB-8, SS-8, SP-61, FP-62, PW-61" (above publications available from the American Plywood Association, 1119 A Street, Tacoma, Washington 98401); (6) Design Guide HP-SG-71, "Structural Design Guide for Hardwood Plywood" (available from the Hardwood Plywood Manufacturers Association, 2310 South Walter Reed Drive, Arlington, Virginia 22206).

(b) No part of any of the above referenced standards shall supersede the general live load requirements of section Ind 53.11.

(6) Reconstituted wood base-fiber and particle panel materials. Materials of this type, when used structurally, shall be approved by the department in accordance with the requirements of section Ind 50.12. Evaluation will be based on ASTM D 1037 [Ind 51.25 (44)].

(7) Solid wood floor and roof sheathing. Minimum thickness of nonstress rated lumber used for floor and roof sheathing shall be in accordance with Table 53-XVI.

TABLE 53-XVI

MINIMUM NET THICKNESS OF LUMBER PLACED (INCHES)

Use	Span (Inches)	Perpendicular to Support		Diagonal to Support	
		Surfaced Dry†	Surfaced Unseasoned	Surfaced Dry†	Surfaced Unseasoned
Floors	24	3/4	25/32	3/4	25/32
	16	5/8	11/16	5/8	11/16
Roofs	24	5/8	11/16	3/4	25/32

†Maximum 19% moisture content.

(a) The above dimensions shall be the minimum dimensions for lumber with grades as specified in Table 53-XVII.

TABLE 53-XVII

MINIMUM BOARD GRADES†

Grading Agency	Solid Floor or Roof Sheathing	Spaced Roof Sheathing
West Coast Lumber Inspection Bureau	Utility	Standard
Western Wood Products Association	4 Common or Utility	3 Common or Standard
Southern Pine Inspection Bureau	No. 3	No. 2
Redwood Inspection Service	Merchantable	Construction, common
National Lumber Grades Authority	4 Common or Utility	3 Common or Standard
Northern Hardwood and Pine Manufacturers Association	4 Common	3 Common
Northeastern Lumber Manufacturers Association	4 Common	3 Common

†The above grades are taken from grading rules approved by the American Lumber Standards Committee.

(8) Timber fasteners. The design and use of timber fasteners shall be in accordance with the requirements of National Design Specifications for Stress-Grade Lumber and Its Fastenings [Ind 51.27(8)].

(a) Fastener identification. Light gauge perforated metal plate connectors shall be permanently identifiable with regard to their gauge and manufacturer.

Ind 53.62 SPECIAL SYSTEMS.

(1) Wood trusses. Wood trusses shall be constructed in accordance with the following recommended standard and the listed exceptions:

(a) "Design Specifications for Light Metal Plate Connected Trusses" [Ind 51.27 (10)].

1. Exceptions and additions:

a. Section 301.2. Moment coefficients used in design of top or bottom chord members shall be based on the assumption of no fixity at member ends or joints due to plate connectors.

b. Metal plate connectors shall be identifiable as stated in Ind 53.61(8)(a).

(b) For trusses with nail-glued plywood gusset plates, calculations and design reference source shall be submitted to the department.

(c) Mechanically fastened trusses shall conform to Part V, "Timber Connector Joints," of National Design Specifications [Ind 51.27 (8)].

Ind 53.63 MINIMUM CONSTRUCTION REQUIREMENTS. The requirements of this section shall apply to all wood framing.

Note: Recognized wood framing and construction details indicated in "Wood Construction Data No. 1 and No. 5" of the National Forest Products Association, Technical Services Division (1619 Massachusetts Ave. NW, Washington, D.C. 20036) is recommended as good design and construction practice.

(1) Fire stops. Fire stops shall be provided at all intersections of interior and exterior walls with floors, ceilings and roof in such manner as to effectively cut off communication by fire through hollow concealed spaces and prevent both vertical and horizontal drafts.

(a) Furred walls shall have fire stops placed immediately above and below the junction of any floor construction with the walls, or shall be fire-stopped the full depth of the joist.

(b) All spaces between chimneys and wood framing shall be solidly filled with noncombustible material at floor levels.

(c) All wood fire stops as required in this section shall be lumber not less than 2 inches in nominal thickness, or 3/4-inch thick plywood with joints backed, and not less in width than the enclosed space within the partition except as provided for chimneys. Fire stops may also be of gypsum board, cement asbestos board, mineral wool or other approved noncombustible materials, securely fastened in place.

(2) Wood framing into fire-rated masonry walls. See Ind 51.045 (1) (m).

(3) Fire-cutting. Wood members supported in masonry walls shall have the ends of such members splayed or firecut to allow free end rotation in the vertical plane of the member, out of the masonry wall. See also Ind 53.34 (3) (b) 5. b.

(4) Bearing.

(a) Joists and trusses. The ends of each joist or truss shall have not less than 1-1/2-inch length of bearing on wood or metal nor less than 3-inch length on hollow or solid masonry units.

(b) Beams and girders. The ends of beams or girders supported on masonry or concrete shall have not less than 4-inch length of bearing. See also Ind 53.34 (3).

(5) Notching and drilling. No notching of outer fibers of structural members is permitted unless substantiated by design calculations. Circular holes bored in joists and studs that are within the middle one-third of the depth of joist or studs are permitted without design calculations.

(6) Decay prevention. Where wood is used in parts of a building exposed to moisture that causes the moisture content of wood to exceed 19 percent, the wood shall be adequately ventilated or treated with preservative in accordance with the following standards: AWPA C 1, AWPA C 2, and AWPA C23 [Ind 51.27 (7)].

(a) All wood columns, posts and frame legs whose base is subject to deterioration due to moisture shall bear on concrete or other inorganic materials which extend at least 3 inches above the adjacent surface unless treated with preservative.

(b) The ends of wood structural members built into exterior masonry walls or into concrete shall be treated with preservative or a moisture-proof barrier shall be installed on the bearing surface.

Note: In areas subject to termite attack, refer to "Design of Wood Structures for Permanence" (published by the National Forest Products Association, 1619 Massachusetts Ave. NW, Washington, D. C. 20036) as suggested by National Design Specifications [Ind 51.27 (8)], Appendix F, section B.2.

(7) Truss bracing and anchorage. All wood trusses shall be securely fastened to the supports and each truss shall be secured in position in accordance with National Design Specifications [Ind 51.27 (8)], Appendix F, section J.

(8) Anchorage. Anchorage shall be in accordance with subsection Ind 53.12 (2).

(9) Cross bridging. Cross bridging shall be furnished in accordance with paragraph 300-J of NDS [Ind 51.27 (8)]. When joists support floor or roof decks other than wood or wood decks which are not adequately attached, cross bridging shall be provided at 8-foot intervals.

(10) Solid blocking. All floor and roof joists shall be supported laterally at the ends and at each support by solid blocking except when the ends of joists are nailed to a header, band or rim joist or to an adjoining stud. Solid blocking shall be provided between floor joists where subjected to concentrated loads. Solid blocking shall be not less than 2 inches in nominal thickness and the full depth of the joist.

(11) Joist support. Floor or roof joists shall not be toe nailed into the side of beams and girders for support. Such joists shall be supported by joist hangers, ledgers or metal plate connectors of adequate structural capacity.

(12) Stud walls. Unless evidence is provided to indicate otherwise, the maximum spacing and height of studs shall be in accordance with Table 53-XVIII. Notching and drilling of studs shall conform to subsection Ind 53.63 (5). Where load-bearing studs are spaced at 24-inch intervals, the roof trusses, rafters, and joists shall be centered over the studs or, in lieu thereof, solid blocking equal in size to the studs shall be installed to reinforce the double plate above.

(13) Minimum recommended nailing schedule. Unless evidence of design for the connection is provided, the connection shall have a minimum nailing in accordance with Table 53-XIX or its equivalent.

TABLE 53-XVIII

MAXIMUM SPACING AND HEIGHT OF STUDS

Size	Grade Referring to F_b and F_c	Height (Feet)	Spacing (Inches)	
			Exterior or Load-Bearing	Interior and Non-Load-Bearing
2 by 4 or larger	Utility	8	16	24
2 by 3	Standard and better	8	16	16
2 by 4 3 by 4	Standard and better	12	16	24
2 by 6 or larger	Standard and better	18	24	24

TABLE 53-XIX

MINIMUM RECOMMENDED NAILING SCHEDULE

Connection	Nailing (using common nails)
Joist to sill or girder, toe nail	3-8d
Bridging to joist, toe nail each end	2-8d
Ledger strip	3-16d at each joist
1" x 6" subfloor or less to each joist, face nail	2-8d
Over 1" x 6" subfloor to each joist, face nail	3-8d
2" subfloor to joist or girder, blind and face nail	2-16d
Sole plate to joist or blocking, face nail	16d at 16" oc
Top plate to stud, end nail	2-16d
Stud to sole plate, toe nail	4-8d
Doubled studs, face nail	16d at 24" oc
Doubled top plates, face nail	16d at 16" oc
Top plates, laps and intersections, face nail	2-16d
Continuous header, two pieces	16d at 16" oc along each edge
Ceiling joists to plate, toe nail	3-8d
Continuous header to stud, toe nail	4-8d
Ceiling joists, laps over partitions, face nail	3-16d
Ceiling joists to parallel rafters, face nail	3-16d
Rafter to plate, toe nail	3-8d
One-inch brace to each stud and plate, face nail	2-8d
1" x 8" sheathing or less to each bearing, face nail	2-8d
Over 1" x 8" sheathing to each bearing, face nail	3-8d
Built-up corner studs	16d at 24" oc
Built-up girders and beams	20d at 32" oc along each edge