

UNIFORM BUILDING CODE

**1964
EDITION**



Preface

THE UNIFORM BUILDING CODE is dedicated to the development of better building construction and greater safety to the public, through the elimination of needless red tape, favoritism, and local politics by uniformity in building laws; to the granting of full justice to all building materials on the fair basis of the true merits of each material; and to the development of a sound economic basis for the future growth of cities through unbiased and equitable dealing with structural design and fire hazards.

THE UNIFORM BUILDING CODE was first published by the Pacific Coast Building Officials Conference at the Sixth Annual Business Meeting held in Phoenix, Arizona, October 18-21, 1927.

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The 1964 Edition of the Uniform Building Code contains new chapters, sections, subsections, and standards approved by the Active Class A members at the Forty-First Annual Business Meeting of the International Conference of Building Officials, September 30-October 4, 1963.

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EFFECTIVE USE OF THE UNIFORM BUILDING CODE

The following procedure may be helpful in using the Uniform Building Code:

1. **Classify the building:**

- A. **FIRE ZONE:** Determine the fire zone in which the building is located from the city's Fire District Zoning Map. See Chapter 16 for requirements based on Fire Zone.
- B. **OCCUPANCY GROUP:** Determine the Occupancy Group which the use of the building most nearly resembles. See the '01 Sections of Chapters 6 through 15. See Section 503 for buildings with mixed occupancies.
- C. **TYPE OF CONSTRUCTION:** Determine the Type of Construction of the building by the building materials used and the fire resistance of the parts of the building. See Chapters 17 through 22.
- D. **LOCATION ON PROPERTY:** Determine the location of the building on the site and clearances to property lines and other buildings from the plot plan. See Table No. 5-A and '03 Sections of Chapters 18 through 22 for exterior wall and wall opening requirements based on proximity to property lines. See Section 504 for buildings located on the same site.
- E. **FLOOR AREA:** Compute the floor area of the building. See Table No. 5-C for basic allowable floor area based on Occupancy Group and Type of Construction. See Section 506 for allowable increases based on location on property and installation of an approved automatic fire-extinguishing system. See Section 505 (b) for allowable floor area of multistory buildings.
- F. **HEIGHT AND NUMBER OF STORIES:** Compute the height of the building, Section 409, from grade, Section 408, and for the number of stories, Section 420. See Table No. 5-D for the allowable height and number of stories based on Occupancy Group and Type of Construction. See Section 507 for allowable story increase based on the installation of an approved automatic fire-extinguishing system.
- G. **OCCUPANT LOAD:** Compute the occupant load of the building. See Sections 3301 (c) and (d) and Table No. 33-A.

- 2. Verify compliance of the building with detailed Occupancy requirements. See Chapters 6 through 15.
- 3. Verify compliance of the building with detailed Type of Construction requirements. See Chapters 17 through 22.
- 4. Verify compliance of the building with exit requirements. See Chapter 33.
- 5. Verify compliance of the building with detailed Code regulations. See Chapters 28 through 43, Chapters 47 through 52, and Appendix.
- 6. Verify compliance of building with engineering regulations and requirements for materials of construction. See Chapters 23 through 28 and Sections 4714, 4716, 4717 and 4718.

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS

UNIFORM BUILDING CODE

Ordinance No.....

An ordinance regulating the erection, construction, enlargement, alteration, repair, moving, removal, conversion, demolition, occupancy, equipment, use, height, area, and maintenance of buildings or structures in the City of

.....;
providing for the issuance of permits and collection of fees therefor; declaring and establishing Fire Districts; providing penalties for the violation thereof, and repealing all ordinances and parts of ordinances in conflict therewith.

Be it ordained by the.....
of the City of.....as follows:

PART I

ADMINISTRATIVE

CHAPTER 1—TITLE AND SCOPE

Sec. 101. This ordinance shall be known as the “Building Code,” may be cited as such, and will be referred to herein as “this Code.” **Title**

Sec. 102. The purpose of this Code is to provide minimum standards to safeguard life or limb, health, property, and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location and maintenance of all buildings and structures within the city and certain equipment specifically regulated herein. **Purpose**

Sec. 103. The provisions of this Code shall apply to the construction, alteration, moving, demolition, repair, and use of any building or structure within the city, except work located primarily in a public way, public utility towers and poles, mechanical equipment not specifically regulated in this Code, and hydraulic flood control structures. **Scope**

Additions, alterations, repairs, and changes of use or occupancy in all buildings and structures shall comply with the provisions for new buildings and structures except as otherwise provided in Sections 104, 306, and 502 of this Code.

Where, in any specific case, different sections of this Code specify different materials, methods of construction or other requirements, the most restrictive shall govern.

Wherever in this Code reference is made to the Appendix, the provisions in the Appendix shall not apply unless specifically adopted.

Sec. 104. (a) General. Buildings or structures to which additions, alterations, or repairs are made shall comply with all the requirements for new buildings or structures except as specifically provided in this Section. **Application to Existing Buildings**

For construction in Fire Zones see Chapter 16.

(b) Additions, Alterations, and Repairs: More than 50 Per Cent. When additions, alterations, or repairs within any 12-month period exceed 50 per cent of the value of an existing building or structure, such building or structure shall be made to conform to the requirements for new buildings or structures.

(c) Additions, Alterations, and Repairs: 25 to 50 Per Cent. Additions, alterations, and repairs exceeding 25 per cent but not exceeding 50 per cent of the value of an existing building or structure and complying with the require-

**Application
to Existing
Buildings
(Continued)**

ments for new buildings or structures may be made to such building or structure within any 12-month period without making the entire building or structure comply. The new construction shall conform to the requirements of this Code for a new building of like area, height, and occupancy. Such building or structure, including new additions, shall not exceed the areas and heights specified in this Code.

(d) **Additions, Alterations, and Repairs: 25 Per Cent or Less.** Structural additions, alterations, and repairs to any portion of an existing building or structure, within any 12-month period, not exceeding 25 per cent of the value of the building or structure shall comply with all of the requirements for new buildings or structures, except that minor structural additions, alterations, or repairs, when approved by the Building Official, may be made with the same material of which the building or structure is constructed. Such building or structure, including new additions, shall not exceed the areas and heights specified in this Code.

(e) **Nonstructural Alterations and Repairs: 25 Per Cent or Less.** Alterations or repairs, not exceeding 25 per cent of the value of an existing building or structure, which are non-structural and do not affect any member or part of the building or structure having required fire resistance, may be made with the same materials of which the building or structure is constructed.

(f) **Repairs: Roof Covering.** Not more than 25 per cent of the roof covering of any building or structure shall be replaced in any 12-month period unless the new roof covering is made to conform to the requirements of this Code for new buildings or structures.

(g) **Existing Occupancy.** Buildings in existence at the time of the passage of this Code may have their existing use or occupancy continued, if such use or occupancy was legal at the time of the passage of this Code, provided such continued use is not dangerous to life.

Any change in the use or occupancy of any existing building or structure shall comply with the provisions of Sections 306 and 502.

(h) **Maintenance.** All buildings or structures both existing and new, and all parts thereof, shall be maintained in a safe and sanitary condition. All devices or safeguards which are required by this Code in a building or structure when erected, altered, or repaired, shall be maintained in good working order. The owner or his designated agent shall be responsible for the maintenance of buildings and structures.

Sec. 105. Buildings or structures moved into or within the city shall comply with the provisions of this Code for new buildings or structures. Sec Section 1601 (c) for requirements in fire zones.

**Moved
Buildings**

Sec. 106. The provisions of this Code are not intended to prevent the use of any material or method of construction not specifically prescribed by this Code, provided any such alternate has been approved.

**Alternate
Materials and
Methods of
Construction**

The Building Official may approve any such alternate provided he finds that the proposed design is satisfactory and complies with the provisions of Chapter 23, and that the material, method, or work offered is, for the purpose intended, at least the equivalent of that prescribed in this Code in quality, strength, effectiveness, fire resistance, durability, and safety.

The Building Official shall require that sufficient evidence or proof be submitted to substantiate any claims that may be made regarding its use.

For the requirements as an approved fabricator see Sections 305 and 402.

Sec. 107. Whenever there is insufficient evidence of compliance with the provisions of this Code or evidence that any material or any construction does not conform to the requirements of this Code, or in order to substantiate claims for alternate materials or methods of construction, the Building Official may require tests as proof of compliance to be made at the expense of the owner or his agent by an approved agency.

Tests

Test methods shall be as specified by this Code for the material in question. If there are no appropriate test methods specified in this Code, the Building Official shall determine the test procedure.

Copies of the results of all such tests shall be retained for a period of not less than two years after the acceptance of the structure.

CHAPTER 2—ORGANIZATION AND ENFORCEMENT

**Creation of
Department**

Sec. 201. There is hereby established in the city the "Building Department" which shall be under the jurisdiction of the Building Official designated by the appointing authority.

**Powers and
Duties of
Building
Official**

Sec. 202. (a) General. The Building Official is hereby authorized and directed to enforce all the provisions of this Code. For such purpose he shall have the powers of a police officer.

(b) Deputies. In accordance with the procedure and with the approval of the chief appointing authority of the municipality, the Building Official may appoint such number of officers, inspectors and assistants, and other employees as shall be authorized from time to time. He may deputize such employees as may be necessary to carry out the functions of the Building Department.

(c) Reports and Records. The Building Official shall submit a report to the proper city official not less than once a year, covering the work of the department during the preceding period. He shall incorporate in said report a summary of his recommendations as to desirable amendments to this Code.

The Building Official shall keep a permanent, accurate account of all fees and other monies collected and received under this Code, the names of the persons upon whose account the same were paid, the date and amount thereof, together with the location of the building or premises to which they relate.

(d) Right of Entry. Upon presentation of proper credentials the Building Official or his duly authorized representatives may enter at reasonable times any building, structure, or premises in the city to perform any duty imposed upon him by this Code.

(e) Stop Orders. Whenever any building work is being done contrary to the provisions of this Code, the Building Official may order the work stopped by notice in writing served on any persons engaged in the doing or causing such work to be done, and any such persons shall forthwith stop such work until authorized by the Building Official to proceed with the work.

(f) Occupancy Violations. Whenever any structure is being used contrary to the provisions of this Code, the Building Official may order such use discontinued and the structure, or portion thereof, vacated by notice served on any person causing such use to be continued. Such person shall discontinue the use within 10 days after receipt of such notice or

make the structure, or portion thereof, comply with the requirements of this Code; provided, however, that in the event of an unsafe building Section 203 shall apply.

**Powers and
Duties of
Building
Official
(Continued)**

(g) **Liability.** The Building Official or any employee charged with the enforcement of this Code, acting in good faith and without malice for the city in the discharge of his duties, shall not thereby render himself liable personally and he is hereby relieved from all personal liability for any damage that may accrue to persons or property as a result of any act required or by reason of any act or omission in the discharge of his duties. Any suit brought against the Building Official or employee, because of such act or omission performed by him in the enforcement of any provisions of this Code, shall be defended by the legal department of the city until final termination of the proceedings.

(h) **Cooperation of Other Officials.** The Building Official may request, and shall receive so far as may be necessary in the discharge of his duties, the assistance and cooperation of other officials of the city.

Sec. 203. (a) General. All buildings or structures which are structurally unsafe or not provided with adequate egress, or which constitute a fire hazard, or are otherwise dangerous to human life, or which in relation to existing use constitute a hazard to safety or health, or public welfare, by reason of inadequate maintenance, dilapidation, obsolescence, fire hazard, or abandonment, as specified in this Code or any other effective ordinance, are, for the purpose of this Section, unsafe buildings. All such unsafe buildings are hereby declared to be public nuisances and shall be abated by repair, rehabilitation, demolition, or removal in accordance with the procedure specified in Subsections (b), (c), (d), and (e) of this Section.

**Unsafe
Buildings**

(b) **Notice to Owner.** The Building Official shall examine or cause to be examined every building or structure or portion thereof reported as dangerous or damaged and, if such is found to be an unsafe building as defined in this Section, the Building Official shall give to the owner of such building or structure written notice stating the defects thereof. This notice may require the owner or person in charge of the building or premises, within 48 hours, to commence either the required repairs or improvements or demolition and removal of the building or structure or portions thereof, and all such work shall be completed within 90 days from date of notice, unless otherwise stipulated by the Building Official. If necessary, such notice shall also require the building, structure, or portion thereof to be vacated forthwith and not occupied until the required repairs and improvements are completed, inspected, and approved by the Building Official.

**Unsafe
Buildings
(Continued)**

Proper service of such notice shall be by personal service upon the owner of record, if he shall be found within the city limits. If he is not found within the city limits such service may be made upon said owner by registered mail or certified mail, provided, that if such notice is by registered mail or certified mail, the designated period within which said owner or person in charge is required to comply with the order of the Building Official shall begin as of the date he receives such notice.

(c) **Posting of Signs.** The Building Official shall cause to be posted at each entrance to such building a notice to read: "DO NOT ENTER. UNSAFE TO OCCUPY. Building Department, City of....." Such notice shall remain posted until the required repairs, demolition, or removal are completed. Such notice shall not be removed without written permission of the Building Official and no person shall enter the building except for the purpose of making the required repairs or of demolishing the building.

(d) **Right to Demolish.** In case the owner shall fail, neglect, or refuse to comply with the notice to repair, rehabilitate, or to demolish and remove said building or structure or portion thereof, the City Council may order the owner of the building prosecuted as a violator of the provisions of this Code and may order the Building Official to proceed with the work specified in such notice. A statement of the cost of such work shall be transmitted to the City Council, who shall cause the same to be paid and levied as a special assessment against the property.

(e) **Costs.** Costs incurred under Subsection (d) shall be paid out of the City Treasury. Such costs shall be charged to the owner of the premises involved as a special assessment on the land on which the building or structure is located, and shall be collected in the manner provided for special assessments.

**Board of
Appeals**

Sec. 204. In order to determine the suitability of alternate materials and types of construction and to provide for reasonable interpretations of the provisions of this Code, there shall be and is hereby created a Board of Appeals, consisting of five members who are qualified by experience and training to pass upon matters pertaining to building construction. The Building Official shall be an ex officio member and shall act as Secretary of the Board. The Board of Appeals shall be appointed by the Mayor and shall hold office at his pleasure. The Board shall adopt reasonable rules and regulations for conducting its investigations and shall render all decisions and findings in writing to the Building Official with a duplicate copy to the appellant and may recommend to the City Council such new legislation as is consistent therewith.

Sec. 205. It shall be unlawful for any person, firm, or corporation to erect, construct, enlarge, alter, repair, move, improve, remove, convert or demolish, equip, use, occupy, or maintain any building or structure in the city, or cause the same to be done, contrary to or in violation of any of the provisions of this Code.

**Violations
and Penalties**

Any person, firm, or corporation violating any of the provisions of this Code shall be deemed guilty of a misdemeanor, and each such person shall be deemed guilty of a separate offense for each and every day or portion thereof during which any violation of any of the provisions of this Code is committed, continued, or permitted, and upon conviction of any such violation such person shall be punishable by a fine of not more than \$300, or by imprisonment for not more than 90 days, or by both such fine and imprisonment.

CHAPTER 3—PERMITS AND INSPECTIONS

**Application
for Permits**

Sec. 301. (a) Permits Required. No person, firm, or corporation shall erect, construct, enlarge, alter, repair, move, improve, remove, convert, or demolish any building or structure in the city, or cause the same to be done, without first obtaining a separate building permit for each such building or structure from the Building Official.

(b) Application. To obtain a permit the applicant shall first file an application therefor in writing on a form furnished for that purpose. Every such application shall:

1. Identify and describe the work to be covered by the permit for which application is made;
2. Describe the land on which the proposed work is to be done, by lot, block, tract, and house and street address, or similar description that will readily identify and definitely locate the proposed building or work;
3. Show the use or occupancy of all parts of the building;
4. Be accompanied by plans and specifications as required in Subsection (c) of this Section;
5. State the valuation of the proposed work;
6. Be signed by the permittee, or his authorized agent, who may be required to submit evidence to indicate such authority;
7. Give such other information as reasonably may be required by the Building Official.

(c) Plans and Specifications. With each application for a building permit, and when required by the Building Official for enforcement of any provisions of this Code, two sets of plans and specifications shall be submitted. The building official may require plans and specifications to be prepared and designed by an engineer or architect licensed by the state to practice as such.

EXCEPTIONS: When authorized by the Building Official plans and specifications need not be submitted for the following:

1. One-story buildings of Type V conventional wood-stud construction with an area not exceeding six hundred square feet (600 sq. ft.).
2. Group J, Division I, Occupancies of Type V conventional wood-stud construction;
3. Small and unimportant work.

(d) Information on Plans and Specifications. Plans and specifications shall be drawn to scale upon substantial paper or cloth and shall be of sufficient clarity to indicate the nature

**Application
for Permits
(Continued)**

and extent of the work proposed and show in detail that it will conform to the provisions of this Code and all relevant laws, ordinances, rules, and regulations. The first sheet of each set of plans shall give the house and street address of the work and the name and address of the owner and person who prepared them. Plans shall include a plot plan showing the location of the proposed building and of every existing building on the property. In lieu of detailed specifications, the Building Official may approve references on the plans to a specific section or part of this Code or other ordinances or laws.

Computations, stress diagrams, and other data sufficient to show the correctness of the plans, shall be submitted when required by the Building Official.

**Building
Permits**

Sec. 302. (a) Issuance. The application, plans, and specifications filed by an applicant for a permit shall be checked by the Building Official. Such plans may be reviewed by other departments of the city to check compliance with the laws and ordinances under their jurisdiction. If the Building Official is satisfied that the work described in an application for permit and the plans filed therewith conform to the requirements of this Code and other pertinent laws and ordinances, and that the fee specified in Section 303 (a) has been paid, he shall issue a permit therefor to the applicant.

When the Building Official issues the permit, he shall endorse in writing or stamp on both sets of plans and specifications "APPROVED." Such approved plans and specifications shall not be changed, modified, or altered without authorization from the Building Official, and all work shall be done in accordance with the approved plans.

The Building Official may issue a permit for the construction of part of a building or structure before the entire plans and specifications for the whole building or structure have been submitted or approved provided adequate information and detailed statements have been filed complying with all pertinent requirements of this Code. The holder of such permit shall proceed at his own risk without assurance that the permit for the entire building or structure will be granted.

(b) Retention of Plans. One set of approved plans, specifications, and computations shall be retained by the Building Official for a period of not less than 90 days from date of completion of the work covered therein, and one set of approved plans and specifications shall be returned to the applicant, which set shall be kept on such building or work at all times during which the work authorized thereby is in progress.

Plans, submitted for checking, for which no permit is issued, and on which no action is taken by the applicant for 90 days, shall be returned to the last known address of the applicant; to renew action on said plans, a payment of a new plan-check fee shall be required.

**Building
Permits
(Continued)**

(c) **Validity.** The issuance or granting of a permit or approval of plans and specifications shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this Code. No permit presuming to give authority to violate or cancel the provisions of this Code shall be valid, except in so far as the work or use which it authorizes is lawful.

The issuance of a permit based upon plans and specifications shall not prevent the Building Official from thereafter requiring the correction of errors in said plans and specifications or from preventing building operations being carried on thereunder when in violation of this Code or of any other ordinance of the city.

(d) **Expiration.** Every permit issued by the Building Official under the provisions of this Code shall expire by limitation and become null and void, if the building or work authorized by such permit is not commenced within 60 days from the date of such permit, or if the building or work authorized by such permit is suspended or abandoned at any time after the work is commenced for a period of 120 days. Before such work can be recommenced a new permit shall be first obtained so to do, and the fee therefor shall be one-half the amount required for a new permit for such work, provided no changes have been made or will be made in the original plans and specifications for such work; and provided, further, that such suspension or abandonment has not exceeded one year.

(e) **Suspension or Revocation.** The Building Official may, in writing, suspend or revoke a permit issued under provisions of this Code whenever the permit is issued in error or on the basis of incorrect information supplied, or in violation of any ordinance or regulation or any of the provisions of this Code.

Fees

Sec. 303. (a) Building Permit Fees. A fee for each building permit shall be paid to the Building Official as set forth in Table No. 3-A.

The determination of value or valuation under any of the provisions of this Code shall be made by the Building Official.

Where work for which a permit is required by this Code is started or proceeded with prior to obtaining said permit, the fees above specified shall be doubled, but the payment of such double fee shall not relieve any persons from fully complying with the requirements of this Code in the execution of the work nor from any other penalties prescribed herein.

(b) **Plan-Checking Fees.** When the valuation of the proposed construction exceeds \$1,000.00 and a plan is required

TABLE NO. 3-A—BUILDING PERMIT FEES

Fees
(Continued)

TOTAL VALUATION	FEE
Less than \$20.00.....	No Fee
\$20.00, to and including \$100.00.....	\$2.00
More than \$100.00, to and including \$400.00.....	3.00
More than \$400.00, to and including \$700.00.....	5.00
More than \$700.00, to and including \$1,000.00.....	6.00
Each additional \$1,000.00 or fraction, to and including \$25,000.00.....	3.00
Each additional \$1,000.00 or fraction, to and including \$50,000.00.....	2.50
Each additional \$1,000.00 or fraction, to and including \$100,000.00.....	1.50
Each additional \$1,000.00 or fraction, more than \$100,000.00.....	1.00

to be submitted by Subsection (c) of Section 301, a plan-checking fee shall be paid to the Building Official at the time of submitting plans and specifications for checking. Said plan-checking fee shall be equal to one-half of the building permit fee as set forth in Table No. 3-A.

Sec. 304. (a) General. All construction or work for which a permit is required shall be subject to inspection by the Building Official, and certain types of construction shall have continuous inspection by special inspectors, as specified in Section 305.

Inspections

A survey of the lot may be required by the Building Official to verify compliance of the structure with approved plans.

(b) Inspection Record Card. Work requiring a building permit shall not be commenced until the permit holder or his agent shall have posted an inspection record card in a conspicuous place on the front premises and in such position as to allow the Building Official conveniently to make the required entries thereon regarding inspection of the work. This card shall be maintained in such position by the permit holder until the Certificate of Occupancy has been issued.

(c) Approvals Required. No work shall be done on any part of the building or structure beyond the point indicated in each successive inspection without first obtaining the written approval of the Building Official. Such written approval shall be given only after an inspection shall have been made of each successive step in the construction as indicated by each of the inspections required in Subsection (d).

There shall be a final inspection and approval on all buildings when completed and ready for occupancy.

(d) Called Inspections. No reinforcing steel or structural framework of any part of any building or structure shall be

**Inspections
(Continued)**

covered or concealed in any manner whatever without first obtaining the approval of the Building Official.

The Building Official upon notification from the permit holder or his agent shall make the following inspections of Type V buildings and shall either approve that portion of the construction as completed or shall notify the permit holder or his agent wherein the same fails to comply with the law.

1. **FOUNDATION INSPECTION:** To be made after trenches are excavated and forms erected and when all materials for the foundation are delivered on the job. Where concrete from a central mixing plant (commonly termed "transit mixed") is to be used, materials need not be on the job.
2. **FRAME INSPECTION:** To be made after the roof, all framing, fire-blocking, and bracing are in place and all pipes, chimneys, and vents are complete.
3. **LATH INSPECTION:** To be made after all lathing, interior and exterior, is in place and all plastering materials are delivered on the job, but before any plaster is applied.
4. **FINAL INSPECTION:** To be made after building is completed and ready for occupancy.

(e) **Other Inspections.** In addition to the called inspections specified above, the Building Official may make or require any other inspections of any construction work to ascertain compliance with the provisions of this Code and other laws which are enforced by the Building Department.

For the purpose of determining compliance with Section 104 (h), the Building Official may cause any structure to be reinspected.

**Special
Inspections**

Sec. 305. (a) General. In addition to the inspections to be made as specified in Section 304, the owner or his agent shall employ a special inspector who shall be present at all times during construction on the following types of work:

1. **CONCRETE:** On concrete work when the design is based on an "f_c" in excess of 2000 pounds.
2. **MASONRY:** Masonry work shall have special inspection when required in Chapter 24.
3. **WELDING:** On all structural welding.
4. **REINFORCED GYPSUM CONCRETE:** When cast-in-place reinforced gypsum concrete is being mixed or deposited.
5. **SPECIAL CASES:** On special construction or work involving unusual hazards or requiring constant inspection.

EXCEPTION: The Building Official may waive the requirement for the employment of a special inspector if he

PART II

DEFINITIONS AND ABBREVIATIONS

CHAPTER 4—DEFINITIONS AND ABBREVIATIONS

Definitions

Sec. 401. General. For the purpose of this Code, certain abbreviations, terms, phrases, words and their derivatives shall be construed as specified in this Chapter. Words used in the singular include the plural and the plural the singular. Words used in the masculine gender include the feminine, and the feminine the masculine.

A

Sec. 402. AGRICULTURAL BUILDING is a building located on agricultural property and used to shelter farm implements, hay, grain, poultry, livestock, or other farm produce, in which there is no human habitation, and which is not used by the public.

ALLEY is any public space or thoroughfare less than sixteen feet (16') but not less than ten feet (10') in width which has been dedicated or deeded to the public for public use.

ALTER or **ALTERATION** is any change, addition or modification in construction or occupancy.

APARTMENT shall mean a dwelling unit as defined in this Code.

APARTMENT HOUSE is any building, or portion thereof, which is designed, built, rented, leased, let, or hired out to be occupied, or which is occupied as the home or residence of three or more families living independently of each other and doing their own cooking in the said building, and shall include flats and apartments.

APPROVED as to materials and types of construction, refers to approval by the Building Official as the result of investigation and tests conducted by him, or by reason of accepted principles or tests by national authorities, technical or scientific organizations.

APPROVED AGENCY is an established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved by the Building Official.

APPROVED FABRICATOR is an established and qualified person, firm, or corporation approved by the Building Official pursuant to Section 305 (c) of this Code.

AREA (See "Floor Area.")

ASSEMBLY BUILDING is a building or a portion of a building used for the gathering together of 50 or more persons for such purposes as deliberation, worship, entertainment, amusement or awaiting transportation or of 100 or more persons in drinking and dining establishments.

**Definitions
(Continued)**

ATTIC STORY is any story situated wholly or partly in the roof, so designated, arranged, or built as to be used for business, storage, or habitation.

See. 403. **BALCONY** is that portion of the seating space **B** of an assembly room, the lowest part of which is raised four feet (4') or more above the level of the main floor.

BALCONY, EXTERIOR EXIT. See Section 3301 (c).

BASEMENT is that portion of a building between floor and ceiling, which is partly below and partly above grade (as defined in this Chapter), but so located that the vertical distance from grade to the floor below is less than the vertical distance from grade to ceiling. (See "Story.")

BAY WINDOW is a rectangular, curved, or polygonal window, supported on a foundation extending beyond the main wall of the building.

BUILDING is any structure built for the support, shelter, or enclosure of persons, animals, chattels, or property of any kind.

BUILDING, EXISTING, is a building erected prior to the adoption of this Code, or one for which a legal building permit has been issued.

BUILDING OFFICIAL is the officer charged with the administration and enforcement of this Code, or his regularly authorized deputy.

See. 404. **CAST STONE** is a building stone manufactured **C** from cement concrete precast and used as a trim, veneer, or facing on or in buildings or structures.

CELLAR is that portion of a building between floor and ceiling which is wholly or partly below grade (as defined in this Chapter) and so located that the vertical distance from grade to the floor below is equal to or greater than the vertical distance from grade to ceiling. (See "Story.")

CHIEF OF THE FIRE DEPARTMENT is the head of the Fire Department or his regularly authorized deputy.

CITY, as used in this Code, is any political subdivision which adopts this Code for regulation within its jurisdiction.

COURT is a space, open and unobstructed to the sky, located at or above grade level on a lot and bounded on three or more sides by walls of a building.

Definitions
(Continued)
D

* **Sec. 405. DEAD LOAD** in a building is the weight of the walls, permanent partitions, framing, floors, roofs, and all other permanent stationary construction entering into and becoming a part of the building.

DISPERSAL AREA, SAFE. See Section 3322.

DORMITORY is a room occupied by more than two guests.

DWELLING is any building or any portion thereof, which is not an "Apartment House," "Lodging House" or a "Hotel" as defined in this Code, which contains one or two "Dwelling Units" or "Guest Rooms," used, intended, or designed to be built, used, rented, leased, let, or hired out to be occupied, or which are occupied for living purposes.

DWELLING UNIT is one or more habitable rooms which are occupied or which are intended or designed to be occupied by one family with facilities for living, sleeping, cooking and eating.

E

Sec. 406. EXISTING BUILDING. (See "Building, Existing.")

EXIT. See Section 3301 (c).

EXIT COURT. See Section 3301 (c).

EXIT PASSAGEWAY. See Section 3301 (c).

F

Sec. 407. FAMILY is an individual or two or more persons related by blood or marriage or a group of not more than five persons (excluding servants) who need not be related by blood or marriage living together in a dwelling unit.

FIRE ASSEMBLY. See Section 4306 (b).

FIRE RESISTANCE or **FIRE-RESISTIVE CONSTRUCTION** is construction to resist the spread of fire, details of which are specified in Chapters 42 and 43 of this Code.

FIRE-RETARDANT TREATED WOOD is lumber or plywood impregnated with chemicals and when tested in accordance with U.B.C. Standard No. 42-1-64 for a period of 30 minutes shall have a flame-spread of not over 25 and show no evidence of progressive combustion. The fire-retardant properties shall not be considered permanent where exposed to the weather.

All material shall bear identification showing the fire performance rating thereof issued by an approved agency having a re-examination service.

FLOOR AREA is the area included within the surrounding exterior walls of a building or portion thereof, exclusive of vent shafts and courts. The floor area of a building, or portion thereof, not provided with surrounding exterior walls shall be the usable area under the horizontal projection of the roof or floor above.

FOOTING is that portion of the foundation of a structure which spreads and transmits loads directly to the soil or the piles. **Definitions (Continued)**

FRONT OF LOT is the front boundary line of a lot bordering on the street, and in the case of a corner lot may be either frontage.

Sec. 408. GARAGE is a building or portion thereof in which a motor vehicle containing gasoline, distillate or other volatile, flammable liquid in its tank, is stored, repaired, or kept. **G**

GARAGE, PRIVATE, is a building, or a portion of a building, not more than one thousand square feet (1000 sq. ft.) in area, in which only motor vehicles used by the tenants of the building or buildings on the premises are stored or kept. (See Section 1501.)

GARAGE, PUBLIC, is any garage other than a private garage.

GRADE (Ground Level) is the average of the finished ground level at the center of all walls of a building. In case walls are parallel to and within five feet (5') of a sidewalk, alley or other public way, the above ground level shall be measured at the elevation of the sidewalk, alley or public way.

GRADE (Lumber) is the classification of lumber in regard to strength and utility.

GUEST is any person hiring or occupying a room for living or sleeping purposes.

GUEST ROOM is any room or rooms used, or intended to be used by a guest for sleeping purposes. Every one hundred square feet (100 sq. ft.) of superficial floor area in a dormitory is a guest room.

Sec. 409. HABITABLE ROOM is any room meeting the requirements of this Code for sleeping, living, cooking or dining purposes excluding such enclosed spaces as closets, pantries, bath or toilet rooms, service rooms, connecting corridors, laundries, unfinished attics, foyers, storage spaces, cellars, utility rooms and similar spaces. **H**

HEIGHT OF BUILDING is the vertical distance from the "Grade" to the highest point of the coping of a flat roof or to the deck line of a mansard roof or to the average height of the highest gable of a pitch or hip roof.

HORIZONTAL EXIT. See Section 3301 (c).

HOTEL is any building containing six or more guest rooms intended or designed to be used, or which are used, rented or hired out to be occupied, or which are occupied for sleeping purposes by guests.

Definitions
(Continued)

Sec. 410. INCOMBUSTIBLE as applied to building construction material means a material which, in the form in which it is used, is either one of the following:

1. Material of which no part will ignite and burn when subjected to fire. Any material conforming to U.B.C. Standard No. 4-1-64 shall be considered incombustible within the meaning of this Section.

2. Material having a structural base of incombustible material as defined in Section No. 1, with a surfacing material not over one-eighth inch ($\frac{1}{8}$ ") thick which has a flame-spread rating not higher than 50.

"Incombustible" does not apply to surface finish materials. Material required to be incombustible for reduced clearances to flues, heating appliances, or other materials shall refer to material conforming to Section No. 1. No material shall be classed as incombustible which is subject to increase in combustibility or flame-spread rating beyond the limits herein established, through the effects of age, moisture or other atmospheric condition.

Flame-spread rating as used herein refers to rating obtained according to tests conducted as specified in U.B.C. Standard No. 42-1-64.

Sec. 411. No definitions.

Sec. 412. No definitions.

Sec. 413. LINTEL is the beam or girder placed over an opening in a wall, which supports the wall construction above.

LIVE LOADS are all loads except dead and lateral loads.

LODGING HOUSE is any building or portion thereof, containing not more than five guest rooms, which are used by not more than five guests where rent is paid in money, goods, labor or otherwise. A lodging house shall comply with all the requirements of this Code for dwellings.

Sec. 414. MARQUEE is a permanent roofed structure attached to and supported by the building and projecting over public property. Marquees are regulated in Chapter 45.

MASONRY is that form of construction composed of stone, brick, concrete, gypsum, hollow clay tile, concrete block or tile, or other similar building units or materials or combination of these materials laid up unit by unit and set in mortar.

MASONRY, SOLID, is masonry of solid units built without hollow spaces.

MEZZANINE or **MEZZANINE FLOOR** is an intermediate floor placed in any story or room. When the total area of any such "Mezzanine Floor" exceeds $33\frac{1}{3}$ per cent of the total floor area in that room, it shall be considered as constituting

an additional "Story." The clear height above or below a "Mezzanine Floor" construction shall be not less than seven feet (7').

Definitions
(Continued)

Sec. 415. No definitions.

N

Sec. 416. OCCUPANCY is the purpose for which a building is used or intended to be used. The term shall also include the building or room housing such use. Change of occupancy is not intended to include change of tenants or proprietors.

O

OCCUPANT LOAD. See Section 3301 (c).

ORIEL WINDOW is a window which projects from the main line of an enclosing wall of a building and is carried on brackets or corbels.

Sec. 417. PANIC HARDWARE. See Section 3301 (c).

P

PERSON is a natural person, his heirs, executors, administrators, or assigns, and also includes a firm, partnership, or corporation, its or their successors or assigns, or the agent of any of the aforesaid.

PLATFORM, ENCLOSED, is a partially enclosed portion of an assembly room the ceiling of which is not more than five feet (5') above the proscenium opening and which is designed or used for the presentation of plays, demonstrations, or other entertainment wherein scenery, drops, decorations, or other effects may be installed or used.

PUBLIC WAY. See Section 3301 (c).

Sec. 418. No definitions.

Q

Sec. 419. REPAIR is the reconstruction or renewal of any part of an existing building for the purpose of its maintenance. The word "Repair" or "Repairs" shall not apply to any change of construction.

R

Sec. 420. SHAFT is a vertical opening through a building for elevators, dumb-waiters, mechanical equipment, or similar purposes.

S

SHALL as used in this Code, is mandatory.

STAGE is a partially enclosed portion of an assembly building which is designed or used for the presentation of plays, demonstrations, or other entertainment wherein scenery, drops, or other effects may be installed or used, and where the distance between the top of the proscenium opening and the ceiling above the stage is more than five feet (5').

STAIRWAY. Two or more risers shall constitute a stairway.

Definitions
(Continued)

STORY is that portion of a building included between the upper surface of any floor and the upper surface of the floor next above, except that the topmost story shall be that portion of a building included between the upper surface of the topmost floor and the ceiling or roof above. If the finished floor level directly above a basement or cellar is more than six feet (6') above grade such basement or cellar shall be considered a story.

STREET is any thoroughfare or public space not less than sixteen feet (16') in width which has been dedicated or deeded to the public for public use.

STRUCTURE is that which is built or constructed, an edifice or building of any kind, or any piece of work artificially built up or composed of parts joined together in some definite manner.

T **Sec. 421.** No definitions.

U **Sec. 422. U.B.C. STANDARDS** is the 1964 Edition of the "Uniform Building Code Standards," also known as "Volume III" of the Uniform Building Code. (See Chapter 60.)

V **Sec. 423. VALUE or VALUATION** of a building shall be the estimated cost to replace the building in kind, based on current replacement costs, as determined in Section 303 (a).

VENEER is a facing of brick, stone, concrete, tile, metal, or similar material attached to a wall for the purpose of providing ornamentation, protection, or insulation but not counted as adding strength to the wall.

W **Sec. 424. WALLS** shall be defined as follows:

Bearing Wall is a wall which supports any load other than its own weight.

Exterior Wall is any wall or element of a wall, or any member or group of members, which defines the exterior boundaries or courts of a building.

Faced Wall is a wall in which the masonry facing and backing are so bonded as to exert a common action under load.

Nonbearing Wall is a wall which supports no load other than its own weight.

Parapet Wall is that part of any wall entirely above the roof line.

Retaining Wall is any wall used to resist the lateral displacement of any material.

WINDOW. (See "Bay Window"; see "Oriel Window.") **Definitions**

(Continued)

Sec. 425. No definitions.

X

Sec. 426. YARD is an open, unoccupied space, other than **Y**
a court, unobstructed from the ground to the sky, except
where specifically provided by this Code, on the lot on which
a building is situated.

PART III

REQUIREMENTS BASED ON OCCUPANCY

CHAPTER 5—CLASSIFICATION OF ALL BUILDINGS BY USE OR
OCCUPANCY AND GENERAL REQUIREMENTS FOR
ALL OCCUPANCIES**Occupancy
Classified**

Sec. 501. Every building, whether existing or hereafter erected, shall be classified by the Building Official according to its use or the character of its occupancy, as a building of Group A, B, C, D, E, F, G, H, I, or J, as defined in Chapters 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15, respectively. (See Table No. 5-A.)

Any occupancy not mentioned specifically or about which there is any question shall be classified by the Building Official and included in the Group which its use most nearly resembles based on the existing or proposed life and fire hazard.

**Change
in Use**

Sec. 502. No change shall be made in the character of occupancies or use of any building which would place the building in a different division of the same group of occupancy or in a different group of occupancies, unless such building is made to comply with the requirements of this Code for such division or group of occupancy.

EXCEPTION: The character of the occupancy of existing buildings may be changed subject to the approval of the Building Official, and the building may be occupied for purposes in other Groups without conforming to all the requirements of this Code for those Groups, provided the new or proposed use is less hazardous, based on life and fire risk, than the existing use.

No change in the character of occupancy of a building shall be made without a Certificate of Occupancy, as required in Section 306 of this Code.

**Mixed
Occupancy**

Sec. 503. (a) General. When a building is used for more than one occupancy purpose each part of the building comprising a distinct "Occupancy," as described in Chapters 5 through 15, shall be separated from any other occupancy as specified in Section 503 (d).

When a building is used for more than one occupancy purpose, it shall be subject to the most restrictive requirements for the occupancies concerned.

EXCEPTIONS: 1. When a one-story building houses more than one occupancy, each portion of the building shall conform to the requirements for the occupancy housed therein. The area of the building shall be such that the

sum of the actual areas divided by the allowable area for each separate occupancy shall not exceed one.

2. Where minor accessory uses do not occupy more than 10 per cent of the area of any floor of a building, nor more than 10 per cent of the basic area permitted in the occupancy by Table No. 5-C, the major use of the building shall determine the occupancy classification provided the uses are separated as specified in Section 503 (d).

(b) **Forms of Occupancy Separations.** Occupancy separations shall be vertical or horizontal or both or, when necessary, of such other form as may be required to afford a complete separation between the various occupancy divisions in the building.

(c) **Types of Occupancy Separation.** Occupancy separations shall be classed as "Four-Hour Fire-Resistive," "Three-Hour Fire-Resistive," "Two-Hour Fire-Resistive," and "One-Hour Fire-Resistive."

1. A "Four-Hour Fire-Resistive Occupancy Separation" shall have no openings therein and shall be of not less than four-hour fire-resistive construction.

2. A "Three-Hour Fire-Resistive Occupancy Separation" shall be of not less than three-hour fire-resistive construction. All openings in walls forming such separation shall be protected by a fire assembly having a three-hour fire-resistive rating. The total width of all openings in any three-hour fire-resistive occupancy separation wall in any one story shall not exceed 25 per cent of the length of the wall in that story and no single opening shall have an area greater than one hundred and twenty square feet (120 sq. ft.).

All openings in floors forming a "Three-Hour Fire-Resistive Occupancy Separation" shall be protected by vertical enclosures extending above and below such openings. The walls of such vertical enclosures shall be of not less than two-hour fire-resistive construction and all openings therein shall be protected with a fire assembly having a fire-resistive rating as set forth in Table No. 33-B.

3. A "Two-Hour Fire-Resistive Occupancy Separation" shall be of not less than two-hour fire-resistive construction. All openings in such separation shall be protected by a fire assembly having a one and one-half-hour fire-resistive rating.

4. A "One-Hour Fire-Resistive Occupancy Separation" shall be of not less than one-hour fire-resistive construction. All openings in such separation shall be protected by a fire assembly having a one-hour fire-resistive rating.

(d) **Fire Ratings for Occupancy Separations.** Occupancy separations shall be provided between the various groups and divisions of occupancies as set forth in Table No. 5-B. Where any occupancy separation is required the minimum shall be a "One-Hour Fire-Resistive Occupancy Separation."

**Mixed
Occupancy
(Continued)**

Where the occupancy separation is horizontal, structural members supporting the separation shall be protected by equivalent fire-resistive construction.

**Location
on
Property**

Sec. 504. (a) General. Buildings shall adjoin or have access to a public space, yard, or street on not less than one side. Required yards shall be permanently maintained.

For the purpose of this Section, the center line of an adjoining street or alley shall be considered an adjacent property line.

Eaves over required windows shall be not less than thirty inches (30") from the side and rear property lines. For eaves, see Section 1710.

(b) Fire Resistance of Walls. Exterior walls shall have fire-resistance and opening protection as set forth in Table No. 5-A, Part III, and in accordance with such additional provisions as are specified in Part IV and Part V. Distance shall be measured at right angles from the property line. The above provisions shall not apply to walls at right angles to the property line.

Wall or roof projections may extend to a point one-third the distance to the property line from an exterior wall or vertical plane where fire-resistive protection of openings is first required due to location on property whichever is the least restrictive.

When openings in exterior walls are required to be protected due to distance from property line, the sum of the area of such openings shall not exceed 50 per cent of the total area of the wall in each story.

(c) Buildings on Same Property and Buildings Containing Courts. For the purpose of determining the required wall and opening protection, buildings on the same property and court walls shall be assumed to have a property line between them.

When a new building is to be erected on the same property with an existing building, the assumed property line from the existing building shall be the distance to the property line for each occupancy as set forth in Table No. 5-A and Part V.

EXCEPTION: Two or more buildings on the same property may be considered as portions of one building if the aggregate area of such buildings is within the limits specified in Section 505 for a single building.

When the buildings so considered have different occupancies or are of different types of construction, the area shall be that allowed for the most restricted occupancy or construction.

**Allowable
Floor Areas**

Sec. 505. (a) One-Story Areas. The area of a one-story building shall not exceed the limits set forth in Table No. 5-C except as provided in Section 506, nor the limits specified in Chapter 16.

For buildings located in Fire Zone No. 3 the basic area may be increased 33 1/4 per cent.

**Allowable
Floor Areas
(Continued)**

(b) **Areas of Buildings Over One Story.** The total area of all floors of multistory buildings shall not exceed 200 per cent of the area allowed for one-story buildings. No single floor area shall exceed that permitted for one-story buildings. Basements and cellars need not be included in the total allowable areas.

(c) **Separation of Areas.** For the purpose of this Section each portion of the building separated by one or more continuous fire-resistive walls extending from the foundation to the roof at all points may be considered a separate building. Such area separation wall shall be not less than four-hour fire-resistive construction in buildings of Types I, II, III, with all openings protected by a fire assembly having a three-hour fire-resistive rating and shall be not less than two-hour fire-resistive construction in buildings of Types IV and V with all openings protected by a fire assembly having a one and one-half-hour fire-resistive rating except as set forth in Table No. 33-B. The total width of all openings in such fire-resistive wall in each story shall not exceed 25 per cent of the length of the wall in that story.

See Chapters 6 to 16 inclusive for special occupancy provisions.

Sec. 506. (a) General. The floor areas specified in Section 505 may be increased by one of the following:

**Allowable
Area
Increases**

1. **Separation on two sides.** Where public space, streets, or yards more than twenty feet (20') in width extend along and adjoin two sides of the building, floor areas may be increased at a rate of one and one-fourth per cent for each foot by which the minimum width exceeds twenty feet (20'), but the increase shall not exceed 50 per cent.

2. **Separation on three sides.** Where public space, streets, or yards more than twenty feet (20') in width extend along and adjoin three sides of the building, floor areas may be increased at a rate of two and one-half per cent for each foot by which the minimum width exceeds twenty feet (20'), but the increase shall not exceed 100 per cent.

3. **Separation on all sides.** Where public space, streets or yards, more than twenty feet (20') in width extend on all sides of one- and two-story buildings and adjoin the entire perimeter, floor areas may be increased at a rate of five per cent for each foot by which the minimum width exceeds twenty feet (20'). Such increases shall not exceed 100 per cent, except for buildings not exceeding two stories in height of Group C Occupancy and one-story buildings housing aircraft storage hangars and as further limited in Section 1002 (b) for aircraft repair hangars.

TABLE NO. 5-A—WALL AND OPENING PROTECTION OF OCCUPANCIES BASED ON LOCATION ON PROPERTY

TYPES IV AND V CONSTRUCTION: For exterior wall and opening protection of Types IV and V buildings see table below. Type V construction is not permitted within Fire Zone No. 1. Exceptions to limitation for Type IV and Type V construction, as provided in Sections 1109, 2103 and 2203 apply.

(TYPES I, II, AND III CONSTRUCTION: Exterior walls and protection of openings shall be as specified in Sections 1803, 1903, and 2003.)

GROUP	DESCRIPTION OF OCCUPANCY	FIRE ZONE	FIRE RESISTANCE OF EXTERIOR WALLS	OPENINGS IN EXTERIOR WALLS
A	Any assembly building with a stage and an occupant load of 1000 or more in the building.....		Permitted in Type I Buildings only [See Section 602 (a)]	
B See also Section 702	1—Any assembly building with a stage and an occupant load of less than 1000 in the building.....	1	2 hour less than 20 feet 1 hour elsewhere	Not permitted less than 5 feet
	2—Any assembly building without a stage and having an occupant load of 300 or more in the building.....	2 and 3	2 hour less than 10 feet 1 hour elsewhere	Not permitted less than 5 feet Protected less than 10 feet
	3—Any assembly building without a stage and having an occupant load of less than 300 in the building, including such buildings used for school purposes less than eight hours per week.....	1	2 hour less than 20 feet 1 hour elsewhere	Not permitted less than 5 feet Protected less than 20 feet
		2	2 hour less than 5 feet 1 hour elsewhere	Not permitted less than 5 feet Protected less than 10 feet
		3	2 hour less than 5 feet 1 hour less than 10 feet	
	4—Stadiums, reviewing stands, and amusement park structures not included within Group A nor Divisions 1, 2 and 3, Group B, Occupancies.....	1	2 hour less than 20 feet 1 hour elsewhere	Protected less than 20 feet
	2	1 hour	Protected less than 10 feet	
	3	1 hour less than 10 feet		
C See also Section 802	Any building used for school or day-care purposes more than eight hours per week, involving assemblage for instruction, education, or recreation, and not classified in Group A or Divisions 1 and 2, Group B, Occupancies.	1	2 hour less than 20 feet 1 hour elsewhere	Not permitted less than 5 feet Protected less than 20 feet
		2	2 hour less than 10 feet 1 hour elsewhere	Not permitted less than 5 feet Protected less than 10 feet
		3	2 hour less than 5 feet 1 hour less than 10 feet	Not permitted less than 5 feet

- NOTES: (1) See Section 504 for type of walls effected and requirements covering percentage of openings permitted in exterior walls.
 (2) For additional restrictions see Chapters under Occupancy, Fire Zones, and Types of Construction.
 (3) For walls facing streets, yards and public ways see Part V.
 (4) Openings shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating.

(Continued)

TABLE 5-A—(Continued)

D See also Section 902	1—Mental hospitals, mental sanitariums, jails, prisons, reformatories, houses of correction, and buildings where personal liberties of inmates are similarly restrained.....		Permitted in Type I and II Buildings only [See Section 902 (b)]	
	2—Nurseries for full-time care of children under kindergarten age. Hospitals, sanitariums, nursing homes with nonambulatory patients, and similar buildings (each accommodating more than five persons).....	1 2 and 3	2 hour less than 20 feet 1 hour elsewhere 2 hour less than 5 feet 1 hour elsewhere	Not permitted less than 5 feet Protected less than 20 feet Not permitted less than 5 feet Protected less than 10 feet
	3—Nursing homes for ambulatory patients, homes for children of kindergarten age or over (each accommodating more than five persons).....	1 2 and 3	2 hour less than 20 feet 1 hour elsewhere 1 hour	Not permitted less than 3 feet Protected less than 20 feet Not permitted less than 3 feet Protected less than 10 feet
			Not permitted in Fire Zones Nos. 1 and 2	
E See also Section 1002	1—Storage and handling of hazardous and highly inflammable or explosive materials other than flammable liquids.....	3	4 hour less than 5 feet 2 hour less than 10 feet 1 hour less than 20 feet	Not permitted less than 5 feet Protected less than 20 feet
	2—Storage and handling of Class I, II and III flammable liquids, as specified in U.B.C. Standard No. 9-1-64; dry cleaning plants using flammable liquids, paint stores with bulk handling; paint shops and spray painting rooms and shops.....	1	4 hour less than 20 feet 1 hour elsewhere	
	3—Woodworking establishments, planing mills and box factories; shops, factories where loose, combustible fibers or dust are manufactured, processed, or generated; warehouses where highly combustible material is stored.....	2	4 hour less than 5 feet 2 hour less than 10 feet 1 hour elsewhere	
	4—Repair garages.....	3	4 hour less than 5 feet 2 hour less than 10 feet 1 hour less than 20 feet	
	5—Aircraft repair hangars.....		Not permitted in Fire Zones Nos. 1 and 2 except as set forth in Sections 1602 (c) and 1603 (c).	
		3	1 hour less than 60 feet	Protected less than 60 feet
F See also Section 1102	1—Gasoline and service stations, storage garages where no repair work is done except exchange of parts and maintenance requiring no open flame, welding, or the use of highly flammable liquids.....	1	2 hour less than 20 feet 1 hour elsewhere	Not permitted less than 5 feet Protected less than 20 feet
	2—Wholesale and retail stores, office buildings, drinking and dining establishments having an occupant load of less than 100, printing plants, municipal police and fire stations, factories and workshops using material not highly flammable or combustible, storage and sales rooms for combustible goods, paint stores without bulk handling..... See Section 402 for definition of Assembly Buildings	2 3	1 hour 1 hour less than 10 feet	Not permitted less than 5 feet Protected less than 10 feet
	3—Aircraft hangars where no repair work is done except exchange of parts and maintenance requiring no open flame, welding, or the use of highly flammable liquids..... Open parking garages. (For requirements, see Section 1109.)	1 2 3	2 hour less than 20 feet 1 hour elsewhere 1 hour 1 hour less than 20 feet	Not permitted less than 5 feet Protected less than 20 feet

See Notes, page 46.

TABLE NO. 5-A—Continued

GROUP	DESCRIPTION OF OCCUPANCY	FIRE ZONE	FIRE RESISTANCE OF EXTERIOR WALLS	OPENINGS IN EXTERIOR WALLS
G	Ice plants, power plants, pumping plants, cold storage, and creameries, factories and workshops using incombustible and non-explosive materials. Storage and sales rooms of incombustible and nonexplosive materials.....	1	2 hour less than 20 feet 1 hour elsewhere	Not permitted less than 3 feet Protected less than 20 feet
		2	1 hour	Not permitted less than 3 feet Protected less than 10 feet
		3	1 hour less than 3 feet	Not permitted less than 3 feet
H See also Section 1302	Hotels and apartment houses Convents, monasteries (each accommodating more than 10 persons).....	1	2 hour less than 20 feet 1 hour elsewhere	Not permitted less than 3 feet Protected less than 20 feet
		2	1 hour	Not permitted less than 3 feet Protected less than 10 feet
		3	1 hour less than 5 feet	Not permitted less than 3 feet
I	Dwellings and lodging houses.....	1	2 hour less than 20 feet 1 hour elsewhere	Not permitted less than 3 feet Protected less than 20 feet
		2	1 hour	Not permitted less than 3 feet Protected less than 10 feet
		3	1 hour less than 3 feet	Not permitted less than 3 feet
J	1—Private garages, sheds and minor buildings used as accessories only when not over 1000 square feet in area.....	1	2 hour less than 20 feet 1 hour elsewhere	Not permitted less than 3 feet Protected less than 20 feet
		2	1 hour	Not permitted less than 3 feet Protected less than 10 feet
		3	1 hour less than 3 feet (Or may be protected on the exterior with materials approved for 1 hour fire-resistive construction)	Not permitted less than 3 feet
	2—Fences over 6 feet high, tanks and towers.....	1	Incombustible construction not regulated Combustible construction not permitted	
		2	Incombustible construction not regulated Combustible construction to be 1-hour fire-resistive	
		3	Not regulated	

See Notes, page 46.

TABLE NO. 5-B—REQUIRED SEPARATIONS IN BUILDINGS OF MIXED OCCUPANCY
(In Hours)

GROUP	A	B	C	D	E-1	E-2 ¹	E-3	E-4-5	F-1	F-2	F-3	G	H	I	J
A	N	N	N	3	4	4	4	4	4	3	3	3	1	1	1
B		N	N	3	4	4	4	4	3	1	1	1	1	1	1
C			N	1	4	4	4	4	4	1	1	1	1	1	1
D				N	4	4	4	4	4	2	4	4	1	1	3
E-1					N	1	1	1	2	2	2	2	4	4	1
E-2						N	1	1	1	1	1	1	3	3	1
E-3							N	1	1	1	1	1	3	3	1
E-4-5								N	1	1	1	1	3	3	1
F-1									N	1	1	1	3 ²	1	1
F-2										N	1	1	1	N	1
F-3											N	1	1	N	1
G												N	1	N	N
H													N	N	1
I														N	1 ³
J															N

¹Where an approved spray booth, constructed in accordance with Chapter 53, is installed, such booth need not be separated from other Group E Occupancies or from Group F and G Occupancies.

²A one-hour occupancy separation is permitted provided the Group F Division 1 Occupancy is a garage used only for the parking of passenger motor vehicles having a capacity of not more than nine persons per vehicle, no repair work or fueling is done and the area does not exceed three thousand square feet (3000 sq. ft.).

³Provided that materials as approved for one-hour fire-resistive construction on the garage side and a self-closing, tight-fitting solid wood door one and three-eighths inches (1 $\frac{3}{8}$ ") in thickness, shall be permitted.

TABLE NO. 5-C—BASIC ALLOWABLE FLOOR AREA FOR BUILDINGS ONE STORY IN HEIGHT

In Fire Zones No. 1 and No. 2. For Buildings Located in Fire Zone No. 3 the Basic Area May Be Increased 33½ Per Cent
(In Square Feet)

OCCUPANCY	TYPES OF CONSTRUCTION							
	I	II	III		IV		V	
			1-Hour or H.T.	N	1-Hour	N	1-Hour	N
A	Unlimited	Not Permitted						
B) 1-2	Unlimited	13,500	10,100	Not Permitted	10,100	Not Permitted	7900	Not Permitted
B) 3-4	Unlimited	13,500	10,100	6800	10,100	6800	7900	4500
C	Unlimited	20,300	15,200	10,100	15,200	10,100	11,800	6800
D) 1	Unlimited	6800	Not Permitted ¹					
D) 2-3	Unlimited	6800	5100	Not Permitted	5100	Not Permitted	3900	Not Permitted
E) 1-2	11,250	5600	4200	2800	4200	2800	3300	1900
E) 3-4-5	Unlimited	11,300	8400	5600	8400	5600	6600	3800
F) 1-2-3	Unlimited	18,000	13,500	9000	13,500	9000	10,500	6000
G	Unlimited	27,000	20,300	13,500	20,300	13,500	15,800	9000
H	Unlimited	13,500	10,100	6800	10,100	6800	7900	4500
I		Unlimited						
J		See Chapter 15						

N.—No general requirements for fire resistance.

H.T.—Heavy Timber.

¹See Section 902 (b).

(b) **Unlimited Area.** The area of any one- or two-story building of Group F, Group G and Division 5 of Group E Occupancies shall not be limited, if the building is provided with an approved automatic fire-extinguishing system throughout, as specified in Chapter 38, and entirely surrounded and adjoined by public space, streets or yards not less than sixty feet (60') in width.

The area of a one-story Type II, Type III, Heavy-Timber or Type III, One-hour, or Type IV building of Group G Occupancy shall not be limited if the building is entirely surrounded and adjoined by public space, streets, or yards not less than sixty feet (60') in width.

(c) **Automatic Fire-Extinguishing Systems.** The area specified in Section 505 may be tripled in one-story buildings and doubled in buildings of more than one story if the building is provided with an approved automatic fire-extinguishing system throughout as specified in Chapter 38. The area increases permitted in this Subsection may be compounded with that specified in paragraph numbered 1, 2, or 3, of Subsection (a) of this Section. Where other provisions of this Code require approved automatic fire-extinguishing systems the increases permitted in this Section shall not apply.

Sec. 507. The maximum height and number of stories of every building shall be dependent upon the character of the occupancy and the type of construction, and shall not exceed the limits set forth in Table No. 5-D, except as provided in this Section. The height shall be measured from the highest adjoining sidewalk or ground surface, provided that the height measured from the lowest adjoining surface shall not exceed such maximum height by more than ten feet (10').

The limits set forth in Table No. 5-D may be increased by one story if the building is provided with an automatic fire-extinguishing system throughout installed in accordance with the provisions of Chapter 38. The increase in height for sprinklers shall not apply when other provisions of this Code require automatic fire-extinguishing systems throughout or when the increases under Section 506 (c) are used.

**Allowable
Area
Increases
(Continued)**

**Maximum
Height of
Buildings
and
Increases**

EXCEPTIONS: 1. Towers, spires, and steeples, erected as a part of a building and not used for habitation or storage, are limited as to height only by structural design if completely of incombustible materials, or may extend not to exceed twenty feet (20') above the height limit in Table No. 5-D if of combustible materials.

2. The height of one-story aircraft hangars shall not be limited if the building is provided with automatic fire-extinguishing systems throughout as specified in Chapter 38 and is entirely surrounded by public space, streets, or yards not less in width than 150 per cent of the height of the building.

TABLE NO. 5-D—MAXIMUM HEIGHT OF BUILDINGS

OCCUPANCY	TYPES OF CONSTRUCTION							
	I	II	III		IV		V	
			1-Hr. or H.T.	N ¹	1-Hour	N ¹	1-Hour	N ¹
	MAXIMUM HEIGHT IN FEET							
	Unlimited	95	65	55	65	55	50	40
	MAXIMUM HEIGHT IN STORIES							
A	Unlimited	Not Permitted						
B) 1-2	Unlimited	4	2	Not Permitted	2	Not Permitted	2	Not Permitted
B) 3-4	Unlimited	4	2	1	2	1	2	1
C	Unlimited	4 ²	2 ²	1	2 ²	1	2 ²	1
D) 1	Unlimited	2	Not Permitted ¹					
D) 2	Unlimited	3	1 ²	Not Permitted	1 ²	Not Permitted	1 ²	Not Permitted
D) 3	Unlimited	3	2 ²	Not Permitted	2 ²	Not Permitted	2 ²	Not Permitted
E) 1	Unlimited	2	1	1	1	1	1	1
E) 2-3-4-5	Unlimited	2	2	1	2	1	2	1
F) 1-2-3	Unlimited	6	4	2	4	2	3	2
G	Unlimited	6	4	2	4	2	3	2
H	Unlimited	5	4	2	4	2	3	2
I	Unlimited	3	3	3	3	3	3	3
J	See Chapter 15							

N.—No general requirements for fire resistance.
H. T.—Heavy Timber.

¹See Section 802 (a).

²See Section 802 (b).

³See Section 902 (b).

TABLE NO. 5-D

UNIFORM BUILDING CODE

See Chapters 6 to 16 inclusive for special occupancy provisions.

Sec. 508. Where one-hour fire-resistive construction throughout is required by this Code, an approved automatic fire-extinguishing system, as specified in Chapter 38, may be substituted, provided such system is not otherwise required.

**Fire-Resistive
Substitution**

Sec. 509. Arcades connecting buildings and used exclusively as passageways need not be considered as adjacent buildings for the provisions of this Chapter, provided that the walls of the building adjoining the arcades are finished with the same construction as required for the exterior walls of the building, with no communicating openings between the arcades and the building, except doors; and provided that the arcades are of not less than one-hour fire-resistive construction or entirely of incombustible materials, or of heavy timber construction with two-inch (2") nominal sheathing.

Arcades

CHAPTER 6—REQUIREMENTS FOR GROUP A OCCUPANCIES

**Group A
Occupancies
Defined**

Sec. 601. Group A Occupancies shall be:

Any assembly building with a stage and an occupant load of 1000 or more in the building.

For occupancy separations see Table No. 5-B.

For occupant load see Section 3301.

**Construction,
Height,
and Area
Allowable**

Sec. 602. (a) **General.** Buildings or parts of buildings classed in Group A because of the use or character of the occupancy shall be of Type 1 construction and shall not be limited as to location in fire zones, occupant load, height, or area.

(b) **Special Provisions.** Stages and enclosed platforms as defined in Sections 417 and 420 shall be constructed in accordance with Chapter 39.

The slope of the main floor of the assembly room shall not exceed one in five.

**Location
on Property**

Sec. 603. Buildings housing Group A Occupancies shall front directly upon or have access to a public street not less than twenty feet (20') in width. The access to the public street shall be a minimum twenty-foot (20') wide right-of-way unobstructed and maintained only as access to the public street. The main entrance to the building shall be located on the public street or on the access way. The main assembly floor shall be located at or near the adjacent ground level.

For fire-resistive protection of exterior walls and openings, as determined by location on property, see Section 1803.

**Exit
Facilities**

Sec. 604. Stairs, exits, and smokeproof enclosures shall be provided as specified in Chapter 33. (See also Section 3315.)

**Light,
Ventilation,
and
Sanitation**

Sec. 605. All portions of Group A Occupancies customarily used by human beings and all dressing rooms shall be provided with light and ventilation by means of windows or skylights with an area not less than one-eighth of the total floor area, one-half of which shall be openable, or shall be provided with artificial light and a mechanically operated ventilating system. The mechanically operated ventilating system shall supply a minimum of five cubic feet per minute of outside air with a total circulated of not less than 15 cubic feet per minute per occupant in all portions of the building and such system shall be kept continuously in operation during such time as the building is occupied. If the velocity of the air at the register exceeds 10 feet per second, the register shall be placed more than eight feet (8') above the floor directly beneath.

Lights in all parts of the building customarily used by human beings shall be on a separate circuit from that of the

stage and shall be controlled from the box office. All lights in corridors, exit courts and exit passageways shall be protected by a wire cage.

All registers or vents supplying air backstage shall be equipped with automatic closing devices with fusible links. Such closing devices shall be located where the vents or ducts pass through the proscenium walls and shall be operated by fusible links located on both sides of the proscenium wall and both inside of and outside of the vent or duct.

There shall be provided in an approved location at least one lavatory for each two toilets for each sex, and at least one drinking fountain for each floor level.

For requirements for floors and walls of toilet compartments, see Section 1711.

Sec. 606. Exits shall be enclosed as specified in Chapter 33. (For specific requirements see Section 3315.)

Elevator shafts, vent shafts, and other vertical openings shall be enclosed and the enclosure shall be as set forth in Table No. 17-A. (See also Chapter 30.)

Sec. 607. Automatic fire-extinguishing systems, standpipes, and basement pipe inlets shall be installed as specified in Chapter 38.

Sec. 608. Stages shall be equipped with automatic ventilators as required in Section 3901.

Chimneys and heating apparatus shall conform to the requirements of Chapters 37 and 51.

Motion picture machine booths shall conform to the requirements of Chapter 40.

Proscenium curtains shall conform to the requirements set forth in U.B.C. Standard No. 6-1-64.

Flammable liquids shall not be placed or stored in any Group A Occupancy.

Every gas service to the stage portion of the building shall be separated from any other service to the building and each building shall be provided with an approved shutoff valve at a convenient and conspicuous place outside the building and adequately marked.

All exterior openings in a boiler room or room containing central heating equipment if located below openings in another story or if less than ten feet (10') from other doors or windows of the same building shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating. Such fire assemblies shall be fixed, automatic, or self-closing.

Every room containing a boiler or a central heating plant which burns liquid or solid fuel shall be separated from the rest of the building by a Three-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 with all openings protected as set forth in Table No. 33-B.

**Light,
Ventilation,
and
Sanitation
(Continued)**

**Enclosure
of Vertical
Openings**

**Fire-
Extinguishing
Systems,**

**Special
Hazards**

**Special
Hazards
(Continued)**

Every room containing a boiler or a central heating plant which burns gas as fuel shall be separated from the rest of the building by not less than a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 with all openings protected as set forth in Table No. 33-B.

EXCEPTION: Where boilers or central heating plants burning liquid or solid fuel are located at grade level they may be separated from the remainder of the building by a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 with all openings protected by a fire assembly having a one-hour fire-resistive rating, mounted within the boiler room and having closing devices as set forth in Table No. 33-B.

**Exceptions
and
Deviations**

Sec. 609. Gymnasiums and similar occupancies may have running tracks constructed of wood or unprotected steel or iron.

CHAPTER 7—REQUIREMENTS FOR GROUP B OCCUPANCIES

Sec. 701. Group B Occupancies shall be:

**Group B
Occupancies
Defined**

Division 1. Any assembly building with a stage and an occupant load of less than 1000 in the building.

Division 2. Any assembly building without a stage and having an occupant load of 300 or more in the building.

Division 3. Any assembly building without a stage and having an occupant load of less than 300 in the building, including such buildings used for school purposes less than eight hours per week.

Division 4. Stadiums, reviewing stands, and amusement park structures not included within Group A nor Divisions 1, 2, and 3, Group B Occupancies. Specific and general requirements for grandstands, bleachers and reviewing stands are to be found in Chapter 33.

For occupancy separations see Table No. 5-B.

For occupant load see Section 3301.

Sec. 702. (a) General. Buildings or parts of buildings classed in Group B because of the use or character of the occupancy shall not exceed, in area or height, the limits specified in Sections 505, 506, and 507.

**Construction,
Height,
and Area
Allowable**

EXCEPTION: Division 4 structures of open skeleton frame type without roof, cover, or enclosed usable spaces, shall not be limited in area or height.

(b) Special Provisions. Stages and enclosed platforms as defined in Sections 417 and 420 shall be constructed in accordance with Chapter 39.

Divisions 1 and 2 occupancies shall be of not less than one-hour fire-resistive construction throughout, except that a fire-resistive ceiling shall not be required in one-story buildings of Type III, IV, or V construction having an open frame roof. Division 2 occupancies with an occupant load of 1000 or more shall be of Type I, II, or III construction.

EXCEPTION: Gymnasiums which have not more than two balconies, each with an occupant load not to exceed 300, and which are not located over usable spaces, need not have one-hour fire-resistive protection.

Division 3 occupancies located in a basement or above the first story shall be of not less than one-hour fire-resistive construction.

Group B assembly rooms having an occupant load of 1000 or more shall not be located in the basement.

Division 3 occupancies with an occupant load of 50 or more, which are located over usable space, shall be separated

**Construction,
Height,
and Area
Allowable
(Continued)**

from such space by not less than one-hour fire-resistive construction.

For attic space partitions and draft stops see Section 3205.

(c) **Division 4 Provisions.** Erection and structural maintenance of structures housing Division 4 occupancies shall conform to the requirements of this Code, and where there are no such specific requirements, shall provide adequate safety for the loads to which they may be subjected.

Structures housing Division 4 occupancies, other than those of open skeleton frame type, when more than one story in height or four hundred square feet (400 sq. ft.) in area, shall be of not less than one-hour fire-resistive construction.

When the space under a Division 4 occupancy is used for any purpose, it shall be separated from all parts of such Division 4 occupancy, including exits, by walls, floors, and ceilings of not less than one-hour fire-resistive construction.

EXCEPTION: The underside of continuous steel deck grandstands when erected outdoors need not be fire-protected when occupied for public toilets.

The Building Official may cause all Division 4 structures to be re-inspected at least once every six months.

**Location on
Property**

Sec. 703. All buildings housing Group B Occupancies shall front directly upon or have access to a public street not less than twenty feet (20') in width. The access to the public street shall be a minimum twenty-foot (20') wide right-of-way unobstructed and maintained only as access to the public street. The main entrance to the building shall be located on the public street or on the access way.

For fire-resistive protection of exterior walls and openings, as determined by location on property, see Section 504 and Part V.

**Exit
Facilities**

Sec. 704. (a) General. Stairs, exits, and smokeproof enclosures shall be provided as specified in Chapter 33. (See also Section 3316.)

(b) **Amusement Structures.** Stairs and exits for Division 4 amusement structures shall be provided as specified in Chapter 33, subject to the approval of the Building Official. Exit signs shall be installed as specified in Section 3312 and where required by the Building Official.

**Light,
Ventilation,
and
Sanitation**

Sec. 705. All portions of Group B Occupancies customarily used by human beings and all dressing rooms shall be provided with natural or artificial light, ventilation, and sanitary facilities as specified in Sections 605 and 1711.

**Enclosure
of Vertical
Openings**

Sec. 706. Exits shall be enclosed as specified in Chapter 33. (For specific requirements see Section 3316.)

Elevator shafts, vent shafts, and other vertical openings shall be enclosed, and the enclosure shall be as set forth in Table No. 17-A. (See also Chapter 30.)

Sec. 707. Automatic fire-extinguishing systems, standpipes, and basement pipe inlets shall be installed as specified in Chapter 38.

**Fire-
Extinguishing
Systems**

Sec. 708. Chimneys and heating apparatus shall conform to the requirements of Chapters 37 and 51.

**Special
Hazards**

Motion picture machine booths shall conform to the requirements of Chapter 40.

Proscenium curtains shall conform to the requirements set forth in U.B.C. Standard No. 6-1-64.

Flammable liquids shall not be placed or stored in a Group B Occupancy.

Each building shall be provided with an approved outside gas shutoff valve conspicuously marked.

All exterior openings in a boiler room or rooms containing central heating equipment if located below openings in another story or if less than ten feet (10') from other doors or windows of the same building shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating. Such fire assemblies shall be fixed, automatic, or self-closing.

Every room containing a boiler or a central heating plant which burns liquid or solid fuel shall be separated from the rest of the building by a Three-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 with all openings protected as set forth in Table No. 33-B.

Every room containing a boiler or a central heating plant which burns gas as fuel shall be separated from the rest of the building by not less than a One-Hour Fire-Resistive Occupancy Separation, as defined in Chapter 5, with all openings protected as set forth in Table No. 33-B.

EXCEPTION: Where boilers or central heating plants burning liquid or solid fuel are located at grade level they may be separated from the remainder of the building by a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 with all openings protected by a fire assembly having a one-hour fire-resistive rating, mounted within the boiler room and having closing devices as set forth in Table No. 33-B.

Sec. 709. Gymnasiums and similar occupancies may have running tracks constructed of wood or unprotected steel or iron.

**Exceptions
and
Deviations**

In gymnasiums and in multi-purpose schoolrooms having an area not greater than thirty-two hundred square feet (3200 sq. ft.), one-inch (1") nominal tight tongue-and-grooved or three-fourths-inch ($\frac{3}{4}$ ") plywood wall covering may be used on the inner side in lieu of fire-resistive plaster.

CHAPTER 8—REQUIREMENTS FOR GROUP C OCCUPANCIES

**Group C
Occupancies
Defined**

Sec. 801. Group C Occupancies shall be:

Any building used for school or day-care purposes more than eight hours per week, involving assemblage for instruction, education, or recreation, and not classed in Group A Occupancies or in Divisions 1 and 2 of Group B Occupancies.

For occupancy separations see Table No. 5-B.

For occupant load see Section 3301.

**Construction,
Height,
and Area
Allowable**

Sec. 802. (a) **General.** Buildings or parts of buildings classed in Group C because of the use or character of the occupancy shall not exceed, in area or height, the limits specified in Sections 505, 506, and 507.

All buildings housing Group C Occupancies shall be not less than one-hour fire-resistive construction throughout.

EXCEPTIONS: 1. A fire-resistive ceiling is not required in one-story buildings having an open frame roof.

2. One-hour fire-resistive construction is not required throughout where all rooms used for instruction have at least one exit door directly to the outside, provided one-hour fire-resistive construction throughout is not required by other provisions of this Code.

3. Unprotected two-story construction shall be permitted where all rooms used for instruction have at least one conforming exit door directly to the outside at grade or to an exterior exit balcony leading to exterior stairways, each having a total rise not greater than twelve feet (12'). Bearing partitions and columns supporting second floor loads, the floor of the second story and the exit balcony shall be of heavy timber construction or protected to be not less than one-hour fire-resistive. No point in the building shall be more than seventy-five feet (75') from the ground, measured along the exterior exit balcony as the line of egress traveled. The width of the exterior exit balcony and stairways shall conform to Sections 3317 (a) and 3317 (c) respectively.

(b) **Special Provisions.** Rooms having an occupant load of more than 100, and rooms used for kindergarten, first- or second-grade pupils, shall not be located above the first story above grade except in buildings of Type I construction.

Laboratories, wood-working and metal-working shops, machine shops, paint shops, storage rooms, and similar areas shall be separated from each other and from classrooms by not less than a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5.

Where there is usable space under the first floor of two-story Types III, IV, and V buildings, the construction up to and including the first floor shall be of Type I construction, and the first floor shall be unperceivable for human access.

Balconies and bleachers over usable space and all janitor closets shall be protected with materials approved for one-hour fire-resistive construction.

**Construction,
Height,
and Area
Allowable
(Continued)**

All curtains, drops, and drapes shall be flame-proofed.

Stages and enclosed platforms shall be constructed in accordance with Chapter 39.

The provisions of Section 1803 (b) shall not apply to openings in buildings not more than three stories high when such openings are not less than thirty feet (30') from adjacent property lines and not less than thirty feet (30') from buildings on the same property.

For attic space partitions and draft stops, see Section 3205.

Sec. 803. (a) General. All buildings housing Group C Occupancies shall front directly upon or have access to a public street not less than twenty feet (20') in width. The access to the public street shall be a minimum twenty-foot (20') wide right-of-way unobstructed and maintained only as access to the public street. At least one required exit shall be located on the public street or on the access way.

**Location on
Property**

For fire-resistive protection of exterior walls and openings, as determined by location on property, see Section 504 and Part V.

(b) Special Provision. Exterior walls or parts of walls of Group C Occupancies having an occupant load of less than 100 persons, when within ten feet (10') of adjacent property lines, may be of one-hour fire-resistive construction.

Sec. 804. Stairs, exits, and smokeproof enclosures shall be provided as specified in Chapter 33. (See also Section 3317.)

**Exit
Facilities**

Sec. 805. All portions of Group C Occupancies shall be provided with light and ventilation, either natural or artificial, as specified in Section 605.

**Light,
Ventilation,
and
Sanitation**

Toilets shall be provided on the basis of the following ratios of toilets to number of students:

	Girls	Boys
Elementary Schools.....	1:35	1:100
Secondary Schools.....	1:45	1:100

In addition, urinals shall be provided for boys on a basis of 1:30.

There shall be provided at least one lavatory for each two toilets or urinals for each sex and at least one drinking fountain on each floor.

For requirements for floors and walls of toilet compartments, see Section 1711.

Sec. 806. Exits shall be enclosed as specified in Chapter 33. (For specific requirements see Section 3317.)

**Enclosure
of Vertical
Openings**

Elevator shafts, vent shafts, and other vertical openings shall be enclosed, and the enclosure shall be as set forth in Table No. 17-A. (See also Chapter 30.)

**Fire-
Extinguishing
Systems**

Sec. 807. Automatic fire-extinguishing systems, standpipes, and basement pipe inlets shall be installed as specified in Chapter 38.

**Special
Hazards**

Sec. 808. Chimneys and heating apparatus shall conform to the requirements of Chapters 37 and 51.

Motion picture machine booths shall conform to the requirements of Chapter 40.

Each building shall be provided with an approved outside gas shutoff valve conspicuously marked.

All exterior openings in a boiler room or rooms containing central heating equipment if located below openings in another story or if less than ten feet (10') from other doors or windows of the same building shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating. Such fire assemblies shall be fixed, automatic, or self-closing.

Every room containing a boiler or a central heating plant which burns liquid or solid fuel shall be separated from the rest of the building by a Three-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 with all openings protected as set forth in Table No. 33-B.

Every room containing a boiler or a central heating plant which burns gas as fuel shall be separated from the rest of the building by not less than a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 with all openings protected as set forth in Table No. 33-B.

EXCEPTION: Where boilers or central heating plants burning liquid or solid fuel are located at grade level they may be separated from the remainder of the building by a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 with all openings protected by a fire assembly having a one-hour fire-resistive rating, mounted within the boiler room and having closing devices as set forth in Table No. 33-B.

When the opening for a heater or equipment room is protected by a pair of fire doors, the inactive leaf shall be normally secured in the closed position and shall be openable only by the use of a tool. An astragal shall be provided and the active leaf shall be self-closing.

No flammable liquids shall be placed, stored, or used in any Group C Occupancies, except in approved quantities as necessary in laboratories and approved utility rooms, and such liquids shall be kept in tight or sealed containers when not in actual use.

**Exceptions
and
Deviations**

Sec. 809. For requirements for gymnasiums and similar buildings, see Section 709.

Roof covering shall be a "fire-retardant" roofing as specified in Section 3203.

A building which will have only the first floor accessible to not more than 20 pupils at any time, may be used for school purposes with the following exceptions to Code requirements:

Exceptions
and
Deviations
(Continued)

1. Exterior walls or parts of walls which are less than three feet (3') from adjacent property lines shall have no openings therein and shall be of not less than one-hour fire-resistive construction as specified in Chapter 43.

2. Classrooms may have only one exit not less than three feet (3') wide.

CHAPTER 9—REQUIREMENTS FOR GROUP D OCCUPANCIES

**Group D
Occupancies
Defined**

Sec. 901. Group D Occupancies shall be:

Division 1. Mental hospitals, mental sanitariums, jails, prisons, reformatories, and buildings where personal liberties of inmates are similarly restrained.

Division 2. Nurseries for the full-time care of children under kindergarten age (each accommodating more than five persons).

Hospitals, sanitariums, nursing homes with nonambulatory patients and similar buildings (each accommodating more than five persons).

Division 3. Nursing homes for ambulatory patients, homes for children of kindergarten age or over (each accommodating more than five persons).

For occupancy separations see Table No. 5-B.

For occupant load see Section 3301.

EXCEPTION: Group D Occupancies shall not include buildings used only for private residential purposes or for a family group.

**Construction,
Height,
and Area
Allowable**

Sec. 902. (a) General. Buildings or parts of buildings classed in Group D because of the use or character of the occupancy shall not exceed, in area or height, the limits specified in Sections 505, 506, and 507.

(b) Special Provisions. Division 1 occupancies shall be of Type I or II construction throughout.

EXCEPTION: One-story buildings of one-hour fire-resistive construction throughout may be permitted provided the floor area does not exceed thirty-nine hundred square feet (3900 sq. ft.) between separation walls of two-hour fire-resistive construction with openings protected by fire assemblies having one and one-half-hour fire-resistive ratings. See Section 3318 (g), Exception, for locking devices.

Occupancies in which the personal liberties of inmates or patients are restrained within the building shall have floors of incombustible construction.

Divisions 2 and 3 occupancies shall be one-hour fire-resistive construction throughout. Division 2 occupancies more than one story in height and Division 3 occupancies more than two stories in height shall be of Type I or II construction.

For attic space partitions and draft stops, see Section 3205.

**Location on
Property**

Sec. 903. For fire-resistive protection of exterior walls and openings, as determined by location on property, see Section 504 and Part V.

**Exit
Facilities**

Sec. 904. Stairs, exits, and smokeproof enclosures shall be provided as specified in Chapter 33. (See also Section 3318.)

Sec. 905. All portions of Group D Occupancies customarily used by human beings shall be provided with light and ventilation by means of windows or skylights with an area equal to one-eighth of the total floor area, one-half of which shall be openable, or shall be provided with artificial light and a mechanically operated ventilating system as specified in Section 605.

**Light,
Ventilation,
and
Sanitation**

For requirements for floors and walls of toilet compartments see Section 1711.

Sec. 906. Exits shall be enclosed as specified in Chapter 33. (For specific requirements see Section 3318.)

**Enclosure
of Vertical
Openings**

Elevator shafts, vent shafts, and other vertical openings shall be enclosed, and the enclosure shall be as set forth in Table No. 17-A. (Sec also Chapter 30.)

Sec. 907. Automatic fire-extinguishing systems, standpipes, and basement pipe inlets shall be installed as specified in Chapter 38.

**Fire-
Extinguishing
Systems**

Sec. 908. Chimneys and heating apparatus shall conform to the requirements of Chapters 37 and 51.

**Special
Hazards**

Motion picture machine booths shall conform to the requirements of Chapter 40.

Storage of volatile flammable liquids shall not be allowed in Group D Occupancies and the handling of such liquid shall not be permitted in any Group D Occupancies in quantities of more than one gallon unless such handling complies with U.B.C. Standard No. 9-1-64.

Each building shall be provided with an approved outside gas shutoff valve conspicuously marked.

All exterior openings in a boiler room or room containing central heating equipment if located below openings in another story, or if less than ten feet (10') from other doors or windows of the same building, shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating. Such fire assemblies shall be fixed, automatic, or self-closing.

Every room containing a boiler or a central heating plant which burns liquid or solid fuel shall be separated from the rest of the building by a Three-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 with all openings protected as set forth in Table No. 33-B.

Every room containing a boiler or a central heating plant which burns gas as fuel shall be separated from the rest of the building by not less than a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 with all openings protected as set forth in Table No. 33-B.

**Special
Hazards
(Continued)**

EXCEPTION: Where boilers or central heating plants burning liquid or solid fuel are located at grade level they may be separated from the remainder of the building by a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 with all openings protected by a fire assembly having a one-hour fire-resistive rating, mounted within the boiler room and having closing devices as set forth in Table No. 33-B. When the opening for a heater or equipment room is protected by a pair of fire doors, the inactive leaf shall be normally secured in the closed position and shall be openable only by the use of a tool. An astragal shall be provided and the active leaf shall be self-closing.

CHAPTER 10—REQUIREMENTS FOR GROUP E OCCUPANCIES

Sec. 1001. Group E Occupancies shall be:

**Group E
Occupancies
Defined**

Division 1. Storage and handling of hazardous and highly flammable or explosive materials other than flammable liquids.

Division 2. Storage and handling of Class I, II, and III flammable liquids, as set forth in U.B.C. Standard No. 9-1-64; dry-cleaning plants using flammable liquids, paint stores with bulk handling; paint shops and spray painting rooms and shops.

Division 3. Woodworking establishments, planing mills and box factories; shops, factories where loose, combustible fibers or dust is manufactured, processed or generated; warehouses where highly combustible material is stored.

Division 4. Repair garages.

Division 5. Aircraft repair hangars.

For occupancy separations see Table No. 5-B. Where an approved spray booth constructed as set forth in Chapter 53 is installed, such booth need not be separated from other Group E or Groups F and G Occupancies.

For occupant load see Section 3301.

Note: Highly flammable liquids shall be deemed to be those with a flash point below 190°F. as determined by the closed cup tester, provided that liquids with a flash point above 138.5°F. shall not be deemed to be highly flammable when used in a closed safety cleaning system meeting the requirements of U.B.C. Standard No. 10-1-64 for a Class III rating.

Sec. 1002. (a) General. Buildings or parts of buildings classed in Group E because of the use or character of the occupancy shall not exceed, in area or height, the limits specified in Sections 505, 506, and 507.

**Construction,
Height,
and Area
Allowable**

(b) Special Provisions. Division 5 occupancies shall have exterior walls of not less than one-hour fire-resistive construction or shall be surrounded by public space, streets, or yards, not less than sixty feet (60') in width.

The area increases allowed by Section 506 (a) shall not exceed 500 per cent for aircraft repair hangars.

In public garages and where flammable or explosive liquids are used or stored floors shall be entirely protected with incombustible materials against saturation.

In buildings over ninety-five feet (95') in height, the structural frame shall be protected with not less than four-hour fire-resistive protection and the floors shall be of not less than three-hour fire-resistive construction.

**Construction,
Height,
and Area
Allowable
(Continued)**

For attic space partitions and draft stops see Section 3205.

A Division 4 occupancy having a floor area not exceeding twenty-five hundred square feet (2500 sq. ft.) shall have exterior walls of not less than two-hour fire-resistive construction when less than five feet (5') from a property line and of not less than one-hour fire-resistive construction when more than five feet (5') but less than ten feet (10') from a property line, when located in Fire Zone No. 3.

**Location on
Property**

Sec. 1003. For fire-resistive protection of exterior walls and openings, as determined by location on property, see Section 504 and Part V.

**Exit
Facilities**

Sec. 1004. Stairs, exits, and smokeproof enclosures shall be provided as specified in Chapter 33. (See also Section 3319.)

Where ramps are used for the transfer of automobiles from one floor to another such ramps shall meet the ground floor level at a point not less than twenty feet (20') from the exit from such building.

**Light,
Ventilation,
and
Sanitation**

Sec. 1005. All portions of Group E Occupancies customarily used by human beings shall be provided with light and ventilation by means of windows or skylights with an area equal to one-eighth of the total floor area, one-half of which shall be openable, or shall be provided with artificial light and a mechanically operated ventilating system as specified in Section 605.

In all buildings used for the storing or handling of automobiles operated under their own power, and in all buildings where flammable liquids are used, exhaust ventilation shall be provided sufficient to produce one complete change of air every 15 minutes. Such exhaust ventilation shall be taken from a point at or near the floor level.

EXCEPTION: In public garages and aircraft hangars not exceeding an area of five thousand square feet (5000 sq. ft.), the Building Official may authorize the omission of such ventilating equipment where, in his opinion, the building is supplied with unobstructed openings to the outer air which are sufficient to provide the necessary ventilation.

Every building or portion thereof where persons are employed shall be provided with at least one toilet. Every building and each subdivision thereof where both sexes are employed shall be provided with access to at least two toilets located either in such building or conveniently in a building adjacent thereto. All toilet rooms shall be provided with an exterior window at least three square feet (3 sq. ft.) in area, fully openable; or a vertical duct not less than one hundred square inches (100 sq. in.) in area for the first toilet facility with an additional fifty square inches (50 sq. in.) for each additional toilet facility; or a mechanically operated exhaust

system which is connected to the light switch, capable of providing a complete change of air every 15 minutes. Such systems shall be vented to the outside air and at the point of discharge shall be at least five feet (5') from any openable window.

**Light,
Ventilation,
and
Sanitation
(Continued)**

For requirements for floors and walls of toilet compartments, see Section 1711.

Sec. 1006. Exits shall be enclosed as specified in Chapter 33. (For specific requirements see Section 3319.)

**Enclosure
of Vertical
Openings**

Elevator shafts, vent shafts, and other vertical openings shall be enclosed, and the enclosure shall be as set forth in Table No. 17-A. (See also Chapter 30.)

Doors which are part of an automobile ramp enclosure may be kept normally open but shall be equipped with fusible links and so arranged as to be self-closing when released.

Sec. 1007. Automatic fire-extinguishing systems, standpipes, and basement pipe inlets shall be installed as specified in Chapter 38.

**Fire-
Extinguishing
Systems**

Sec. 1008. Chimneys and heating apparatus shall conform to the requirements of Chapters 37 and 51.

**Special
Hazards**

Each building shall be provided with an approved outside gas shutoff valve conspicuously marked.

Every boiler room or room containing a heating plant shall be separated from the rest of the building by a Four-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5.

EXCEPTION: In Divisions 4 and 5, unit heaters may be installed provided they are at least seven feet (7') above the floor.

In any room in which volatile flammable liquids are used or stored no device generating a glow or flame capable of igniting gasoline vapor shall be installed or used within twenty-four inches (24") of the floor.

The use, handling, storage, and sale of gasoline, fuel oil, and other flammable liquids shall not be permitted in any Group E Occupancy unless such use, handling, storage, and sale comply with U.B.C. Standard No. 9-1-64.

Dry cleaning plants in which highly flammable solvents are used or stored shall be of Type I construction and shall not exceed one story in height. All partitions shall be of four-hour fire-resistive construction, except for the necessary openings for the vent ducts, piping, and shafting. All openings in exterior walls except wall vents shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating. Such fire assemblies shall be fixed, automatic, or self-closing. Wall vents having an area of not less than sixteen square inches (16 sq. in.) each, shall be placed in the exterior walls near the floor line, not more than six feet (6') apart horizontally. Each building shall be provided with a power-driven

**Special
Hazards
(Continued)**

fan exhaust system of ventilation which shall be arranged and operated so as to produce a complete change of air in each room every three minutes.

Each machine in dry cleaning establishments which uses a volatile flammable liquid shall have an adequate steam line directly connected to it, so arranged as to have the steam automatically released to the inside of such machine should an explosion occur in the machine.

Equipment or machinery which generates or emits combustible or explosive dust or fibers shall be provided with an adequate dust collecting and exhaust system installed in conformance with U.B.C. Standard No. 10-2-64, unless the building or portion thereof housing such machinery is provided with an automatic fire-extinguishing system conforming to the provisions of Chapter 38. The fire-extinguishing system for such occupancies having a floor area of less than three thousand square feet (3000 sq. ft.) may be a type conforming to the provisions of Exception 2, Section 3802.

CHAPTER 11—REQUIREMENTS FOR GROUP F OCCUPANCIES

Sec. 1101. Group F Occupancies shall be:

**Group F
Occupancies
Defined**

Division 1. Gasoline service stations, storage garages where no repair work is done except exchange of parts and maintenance requiring no open flame, welding, or the use of highly flammable liquids.

Division 2. Wholesale and retail stores, office buildings, drinking and dining establishments having an occupant load of less than 100, printing plants, municipal police and fire stations, factories and workshops using materials not highly flammable or combustible, storage and sales rooms for combustible goods, paint stores without bulk handling. (See Section 402, for definition of Assembly Buildings.)

Division 3. Aircraft hangars where no repair work is done except exchange of parts and maintenance requiring no open flame, welding, or the use of highly flammable liquids.

Open parking garages.

For occupancy separations see Table No. 5-B.

For occupant load see Section 3301.

Sec. 1102. (a) General. Buildings or parts of buildings classed in Group F because of the use or character of the occupancy shall not exceed, in area or height, the limits specified in Sections 505, 506, and 507.

**Construction,
Height,
and Area
Allowable**

(b) Special Provisions. Motor vehicle service stations shall be of incombustible or one-hour fire-resistive construction, including canopies and supports over pumps.

In storage garages and motor vehicle service stations, floors shall be entirely protected against saturation.

Storage areas in excess of one thousand square feet (1000 sq. ft.), in connection with wholesale or retail sales, shall be separated from the public areas by a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5.

For attic space partitions and draft stops see Section 3205.

Sec. 1103. For fire-resistive protection of exterior walls and openings, as determined by location on property, see Section 504 and Part V.

**Location on
Property**

Sec. 1104. Stairs, exits, and smokeproof enclosures shall be provided as specified in Chapter 33.

**Exit
Facilities**

Sec. 1105. All portions of Group F Occupancies customarily used by human beings shall be provided with light and ventilation by means of windows or skylights with an area not less than one-eighth of the total floor area or shall be provided with artificial light and a mechanically operated

**Light,
Ventilation,
and
Sanitation**

**Light,
Ventilation,
and
Sanitation
(Continued)**

ventilating system. In no case shall less than two changes of air per hour be provided.

In all buildings used for the storing or handling of automobiles operated under their own power, and in all buildings where flammable liquids are used, exhaust ventilation shall be provided sufficient to produce one complete change of air every 15 minutes. Such exhaust ventilation shall be taken from a point at or near the floor level.

EXCEPTION: In storage garages and aircraft hangars not exceeding an area of five thousand square feet (5000 sq. ft.), the Building Official may authorize the omission of such ventilating equipment where, in his opinion, the building is supplied with unobstructed openings to the outer air which are sufficient to provide the necessary ventilation.

Every building or portion thereof where persons are employed shall be provided with at least one toilet. Every building and each subdivision thereof where both sexes are employed shall be provided with access to at least two toilets located either in such building or conveniently in a building adjacent thereto.

Such toilet rooms in connection with food establishments where food is prepared, stored, or served, shall have a non-absorbent interior finish on floors, walls, and ceilings, shall be separated from such food establishments with close-fitting, tight doors with a vestibule between, shall have hand washing facilities therein or adjacent thereto.

All toilet rooms shall be provided with an exterior window at least three square feet (3 sq. ft.) in area, fully openable or a vertical duct not less than one hundred square inches (100 sq. in.) in area for the first toilet facility with an additional fifty square inches (50 sq. in.) for each additional toilet facility; or a mechanically operated exhaust system, which is connected to the light switch, capable of providing a complete change of air every 15 minutes. Such systems shall be vented to the outside air and at the point of discharge shall be at least five feet (5') from any openable window.

For requirements for floors and walls of toilet compartments, see Section 1711.

**Enclosure
of Vertical
Openings**

Sec. 1106. Exits shall be enclosed as specified in Chapter 33.

Elevator shafts, vent shafts, and other vertical openings shall be enclosed, and the enclosure shall be as set forth in Table No. 17-A. (See also Chapter 30.)

**Fire-
Extinguishing
Systems**

Sec. 1107. Automatic fire-extinguishing systems, stand-pipes, and basement pipe inlets shall be installed as specified in Chapter 38.

Sec. 1108: Chimneys and heating apparatus shall conform to the requirements of Chapters 37 and 51. **Special Hazards**

No storage of volatile flammable liquids shall be allowed in Group F Occupancies and the handling and use of gasoline, fuel oil and other flammable liquids shall not be permitted in any Group F Occupancy unless such use and handling comply with U.B.C. Standard No. 9-1-64.

Devices generating a glow or flame capable of igniting gasoline vapor shall not be installed or used within twenty-four inches (24") of the floor in any room in which volatile flammable liquids are used or stored.

Every boiler room or room containing a central heating plant using solid or liquid fuel shall be separated from the rest of the building by a Two-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5. Every boiler room or room containing a central heating plant which burns gas as a fuel shall be separated from the rest of the building by not less than a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5.

EXCEPTION: In buildings not more than two stories in height a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5 may be used.

Sec. 1109. (a) Scope. Except where specific provisions are made in the following Subsections, other requirements of this Code shall apply. **Open Parking Garages**

(b) Definition. For the purpose of this Section, an open parking garage is a structure of Type I, II, or IV construction more than one tier in height which is at least 50 per cent open on two or more sides and is used exclusively for the parking or storage of passenger motor vehicles having a capacity of not more than nine persons per vehicle.

(c) Construction. Construction shall be of incombustible materials. Open parking garages shall meet the design requirements of Chapter 23. Adequate curbs and railings shall be provided at every opening.

(d) Area and Height. Area and height of open parking garages in Fire Zones No. 1, No. 2, and No. 3 shall be limited as set forth in Table No. 11-A except for increases allowed by Subsection (e).

(e) Area and Height Increases. Area of structures open on three sides may be increased 25 per cent and one tier in height. Areas of structures open on four sides may be increased 50 per cent and one tier in height.

(f) Location on Property. When located adjacent to interior property lines, exterior walls shall be of the degree of fire resistance set forth in Table No. 11-B and such walls shall be without openings.

**Open
Parking
Garages
(Continued)**

**TABLE NO. 11-A—OPEN PARKING GARAGES
AREA AND HEIGHT**

TYPE	AREA	HEIGHT
Type I	Unlimited	Unlimited
Type II	75,000 per tier	7 stories, 8 tiers
Type IV—one-hour	50,000 per tier	5 stories, 6 tiers
Type IV—unprotected	30,000 per tier	3 stories, 4 tiers

**TABLE NO. 11-B—OPEN PARKING GARAGES
EXTERIOR WALLS**

DISTANCE FROM PROPERTY LINE TO BUILDING	FIRE ZONE NO. 1	FIRE ZONE NO. 2	FIRE ZONE NO. 3
0'-10'	2-hour	2-hour	1-hour
10'-20'	1-hour	1-hour	None

(g) **Stairs and Exits.** Where persons other than parking attendants are permitted, stairs and exits shall meet the requirements of Chapter 33, based on an occupant load of two hundred square feet (200 sq. ft.) per occupant. Where no persons other than parking attendants are permitted there shall be not less than two stairs three feet (3') wide. Lifts may be installed for use of employees only, provided they are completely enclosed by incombustible materials.

(h) **Standpipes.** Standpipes shall not be required.

(i) **Occupancy Separations.** Occupancy separations shall be installed as required in Chapter 5 between open parking garages and other occupancy such as sale of gasoline or oil.

(j) **Fire-extinguishing Apparatus.** Automatic fire-extinguishing systems shall be installed as specified in Chapter 38.

(k) **Enclosure of Vertical Openings.** Enclosure shall not be required for vertical openings except as specified in Subsection (g) for stairs, exits, and lifts.

(l) **Ventilation.** Ventilation, other than the percentage of openings specified in Subsection (b), shall not be required.

(m) **Prohibitions.** The following uses and alterations are not permitted:

1. Automobile repair work.
2. Parking of busses, trucks, and similar vehicles.
3. Partial or complete closing of required openings in exterior walls by tarpaulins or any other means.

CHAPTER 12—REQUIREMENTS FOR GROUP G OCCUPANCIES

Sec. 1201. Group G Occupancies shall be:

Ice plants, power plants, pumping plants, cold storage, creameries.

Factories and workshops using incombustible and nonexplosive materials.

Storage and sales rooms of incombustible and nonexplosive materials.

For occupancy separations see Table No. 5-B.

For occupant load see Section 3301.

**Group G
Occupancies
Defined**

Sec. 1202. (a) General. Buildings or parts of buildings classed in Group G because of the use or character of the occupancy shall not exceed, in area or height, the limits specified in Sections 505, 506, and 507.

**Construction,
Height,
and Area
Allowable**

(b) Special Provisions. Fire protection of the underside of roof framing may be omitted in all Types of Construction.

For attic space partitions and draft stops see Section 3205.

Sec. 1203. For fire-resistive protection of exterior walls and openings, as determined by location on property, see Section 504 and Part V.

**Location on
Property**

Sec. 1204. Stairs, exits, and smokeproof enclosures shall be provided as specified in Chapter 33.

**Exit
Facilities**

Sec. 1205. All portions of Group G Occupancies customarily used by human beings shall be provided with light and ventilation as specified in Section 1105.

**Light,
Ventilation,
and
Sanitation**

Every building or portion thereof where persons are employed shall be provided with at least one toilet. Every building and each subdivision thereof where both sexes are employed shall be provided with access to at least two toilets located either in such building or conveniently in a building adjacent thereto.

For requirements for floors and walls of toilet compartments, see Section 1711.

Sec. 1206. Interior stairways, ramps and escalators shall be enclosed as specified in Chapter 33. Other vertical openings are not required to be enclosed.

**Enclosure
of Vertical
Openings**

Sec. 1207. Automatic fire-extinguishing systems, standpipes, and basement pipe inlets shall be installed as specified in Chapter 38.

**Fire-
Extinguishing
Systems**

Sec. 1208. Chimneys and heating apparatus shall conform to the requirements of Chapters 37 and 51.

**Special
Hazards**

**Special
Hazards
(Continued)**

In any room in which volatile flammable liquids are used or stored, no device generating a glow or flame capable of igniting gasoline vapor shall be installed or used within twenty-four inches (24") of the floor.

The storage, use, and handling of gasoline, fuel oil, and other flammable liquids shall not be permitted in any Group G Occupancy unless such storage, use, and handling comply with U.B.C. Standard No. 9-1-64.

Every boiler room or room below the first floor containing a heating plant shall be separated from the rest of the building by a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5.

CHAPTER 13—REQUIREMENTS FOR GROUP H OCCUPANCIES

Sec. 1301. Group H Occupancies shall be:

Hotels and apartment houses.

Convents and monasteries (each accommodating more than 10 persons).

For occupancy separations see Table No. 5-B.

For occupant load see Section 3301.

**Group H
Occupancies
Defined**

Sec. 1302. (a) General. Buildings or parts of buildings classed in Group H because of the use or character of the occupancy shall not exceed, in area or height, the limits specified in Sections 505, 506, and 507.

**Construction,
Height,
and Area
Allowable**

(b) Special Provisions. Group H Occupancies more than two stories in height or having more than three thousand square feet (3000 sq. ft.) of floor area above the first floor shall be of not less than one-hour fire-resistive construction throughout.

For attic space partitions and draft stops see Section 3205.

Sec. 1303. For fire-resistive protection of exterior walls and openings, as determined by location on property, see Section 504 and Part V.

**Location on
Property**

Sec. 1304. Stairs, exits, and smokeproof enclosures shall be as specified in Chapter 33.

**Exit
Facilities**

All stairs and exits in Group H Occupancies shall open directly upon a street or alley or upon a yard or court not less than four feet (4') in width directly connected to a street or alley by means of a passageway not less in width than the stairway opening into such passageway and not less than seven feet (7') in height.

Buildings more than one story in height shall have no transoms or ventilating openings from guest rooms to public corridors.

Door openings from guest rooms to public corridors shall be protected with a fire-resistive assembly as set forth in Table No. 33-B.

Sec. 1305. (a) Windows. All living rooms, kitchens, and other rooms used for living, dining, or sleeping purposes shall be provided with windows with an area not less than twelve square feet (12 sq. ft.), nor one-eighth of the floor area of such rooms.

**Light,
Ventilation,
and
Sanitation**

The window area in bathrooms, water closet compartments, and other similar rooms shall be not less than three square feet (3 sq. ft.) unless a mechanical ventilation system capable of producing a change of air every five minutes and connected directly to the outside is provided.

**Light,
Ventilation,
and
Sanitation
(Continued)**

When such required windows are installed, not less than one-half of the required area shall be openable.

Required windows shall open on a court, yard, or street either directly or through a porch with a minimum clear height of not less than seven feet (7') and a depth of not more than seven feet (7'). Such porch shall be at least 50 per cent open on at least two sides.

The width of such courts or yards shall be not less than three feet (3') when such courts or yards are not more than two stories high measured down from the top of the building and shall be increased at the rate of six inches (6") for each additional story in height. If such court is entirely surrounded by the building, it shall have a width at least 50 per cent greater than that otherwise required.

(b) **Room Sizes and Ceiling Heights.** Every room required to have windows by Subsection (a) shall have a ceiling height of not less than seven feet six inches (7' 6") in at least 50 per cent of its required area with no portion of the required area less than five feet (5') in height. Rooms used for living, dining, or sleeping purposes shall have an area of not less than ninety square feet (90 sq. ft.). Kitchens shall have a superficial floor area of not less than fifty square feet (50 sq. ft.); superficial floor area being herein defined as clear floor space, exclusive of fixed or built-in cabinets or appliances.

(c) **Sanitation.** Every building shall be provided with at least one toilet. Every hotel and each subdivision thereof where both sexes are accommodated shall be provided with at least two toilets located in such building, which shall be conspicuously marked, one for each sex.

Additional toilets shall be provided on each floor for each sex at the rate of one for every additional 10 guests, or fractional part thereof, in excess of 10.

One toilet shall be provided for each apartment.

There shall be no opening from a room in which a water closet is located into a room in which food is prepared or stored.

A kitchen sink shall be installed in every kitchen.

For requirements for floors and walls of toilet compartments, see Section 1711.

**Enclosure
of Vertical
Openings**

Sec. 1306. Exits shall be enclosed as specified in Chapter 33.

Elevator shafts, vent shafts, and other vertical openings shall be enclosed and the enclosure shall be as set forth in Table No. 17-A. (See also Chapter 30.)

Sec. 1307. Automatic fire-extinguishing systems, stand-pipes, and basement pipe inlets shall be installed as specified in Chapter 38.

Fire-Extinguishing Systems

Sec. 1308. Chimneys and heating apparatus shall conform to the requirements of Chapters 37 and 51.

Special Hazards

The storage and handling of gasoline, fuel oil, and other flammable liquids shall not be permitted in any Group H Occupancy unless such storage and handling comply with U.B.C. Standard No. 9-1-64.

Doors leading into rooms in which volatile flammable liquids are stored or used shall be protected by a fire assembly having a one-hour fire-resistive rating. Such fire assembly shall be self-closing and shall be posted with a sign on each side of the door in one-inch (1") block letters stating: "FIRE DOOR—KEEP CLOSED."

Every boiler room or room containing a central heating plant using solid or liquid fuel shall be separated from the rest of the building by a Three-Hour Fire-Resistive Occupancy Separation, as specified in Chapter 5, with all openings protected as set forth in Table No. 33-B.

EXCEPTIONS: 1. Such furnaces may be used without a Fire-Resistive Occupancy Separation as defined in Chapter 5, in buildings not more than two stories in height.

2. Where boilers or central heating plants burning liquid or solid fuel are located at grade level they may be separated from the remainder of the building by a One-Hour Fire-Resistive Occupancy Separation, as defined in Chapter 5, with all openings protected by a fire assembly having a one-hour fire-resistive rating, mounted within the boiler room and having closing devices as set forth in Table No. 33-B.

Sec. 1309. For existing buildings see Appendix Section 1309.

Existing Buildings

CHAPTER 14—REQUIREMENTS FOR GROUP I OCCUPANCIES

**Group I
Occupancies
Defined**

Sec. 1401. Group I Occupancies shall be:

Dwellings and lodging houses.

For occupancy separations see Table No. 5-B.

For occupant load see Section 3301.

**Construction,
Height,
and Area
Allowable**

Sec. 1402. Buildings or parts of buildings classed in Group I because of the use or character of the occupancy shall not exceed, in area or height, the limits specified in Sections 505, 506, and 507.

**Location on
Property**

Sec. 1403. For fire-resistive protection of exterior walls and openings, as determined by location on property, see Section 504 and Part V.

**Exit
Facilities**

Sec. 1404. Stairs and exits shall be provided as specified in Chapter 33.

**Light,
Ventilation,
and
Sanitation**

Sec. 1405. (a) **Windows.** All living rooms, kitchens, and other rooms used for living, dining, or sleeping purposes shall be provided with windows with an area not less than twelve square feet (12 sq. ft.) nor one-eighth of the floor area of such rooms.

The window area in bathrooms, water-closet compartments, and other similar rooms shall be not less than three square feet (3 sq. ft.), unless a mechanical ventilation system capable of producing a change of air every five minutes and connected directly to the outside is provided.

When such required windows are installed, not less than one half the required area shall be openable.

Required windows shall open on a court, yard, or street either directly or through a porch with a minimum clear height of not less than seven feet (7'). Such porch shall be at least 50 per cent open on at least one side.

(b) **Room Sizes and Ceiling Heights.** Every room regulated by Subsection (a) shall have a ceiling height of not less than seven feet six inches (7' 6") in at least 50 per cent of its required area with no portion less than five feet (5') in height. Rooms used for living, dining, or sleeping purposes shall have an area of not less than eighty square feet (80 sq. ft.). Kitchens shall have a superficial floor area of not less than fifty square feet (50 sq. ft.). Superficial floor area is herein defined as clear floor space, exclusive of fixed or built-in cabinets or appliances.

(c) **Sanitation.** There shall be no opening from a room in which a water closet is located into a room in which food is prepared or stored.

A kitchen sink shall be installed in every kitchen.

(d) **Bathroom.** A minimum bathroom facility consisting of a water closet, lavatory, and bathtub or shower shall be provided in every dwelling.

Sec. 1406. Dumb-waiter shafts, clothes chutes, and other vertical openings shall be enclosed and the enclosure shall be as set forth in Table No. 17-A. (See also Chapter 30.)

**Enclosure
of Vertical
Openings**

Sec. 1407. Fire-extinguishing systems when installed shall conform to the requirements of Chapter 38.

**Fire-
Extinguishing
Systems**

Sec. 1408. Chimneys and heating apparatus shall conform to the requirements of Chapters 37 and 51.

**Special
Hazards**

Flammable liquids shall not be stored or used in Group I Occupancies in quantities in excess of one gallon and all such flammable liquids shall be kept in tight or sealed containers when not in actual use.

Sec. 1409. A carport open on two or more sides need not have a fire separation between the carport and the dwelling.

**Exceptions
and
Deviations**

Windows between the carport and the dwelling shall not be openable. Doors may be of any type, provided that any sash used in a door be fixed; doors between a dwelling and a carport shall be self-closing.

CHAPTER 15—REQUIREMENTS FOR GROUP J OCCUPANCIES

**Group J
Occupancies
Defined**

Sec. 1501. Group J Occupancies shall be:

Division 1. Private garages, sheds, and agricultural buildings when not over one thousand square feet (1000 sq. ft.) in area.

Division 2. Fences over six feet (6') high, tanks, and towers.

For occupancy separations see Table No. 5-B.

For occupant load see Section 3301.

**Construction,
Height,
and Area
Allowable**

Sec. 1502. Buildings or parts of buildings classed in Group J because of the use or character of the occupancy shall be one of the Types of Construction as specified in Part V of this Code. The floor area shall not exceed one thousand square feet (1000 sq. ft.). The height shall not exceed one story.

When any building exceeds the limit specified in this Chapter it shall be classed in the occupancy group other than Group J that it most nearly resembles.

**Location on
Property**

Sec. 1503. For fire-resistive protection of exterior walls and openings, as determined by location on property, see Section 504 and Part V.

**Light and
Ventilation**

Sec. 1504. Private garages which are constructed in conjunction with any Group H or I Occupancy and which have openings into such buildings shall be equipped with fixed louvered or screened openings or exhaust ventilation with exhaust openings located within six inches (6") of the floor. The clear area of the louvered opening or of the openings into the exhaust ducts shall be not less than sixty square inches (60 sq. in.) per car stored in such private garage. Under no circumstances shall a private garage have any opening directly into a room used for sleeping purposes.

Private garage floor surfaces shall be of approved incombustible material.

**Special
Hazards**

Sec. 1505. Chimneys and heating apparatus shall conform to the requirements of Chapters 37 and 51.

Flammable liquids shall not be stored, handled, or used in Group J Occupancies unless such storage or handling shall comply with U.B.C. Standard No. 9-1-64.

PART IV

REQUIREMENTS BASED ON LOCATION IN FIRE ZONES

CHAPTER 16—RESTRICTIONS IN FIRE ZONES

Sec. 1601. (a) Fire Zones Defined. For the purpose of this Code, the entire city is hereby declared to be and is hereby established a Fire District and said Fire District shall be known and designated as Fire Zones One, Two, and Three, and shall include such territory or portions of said City as outlined in an ordinance of said City, entitled: "An Ordinance Creating and Establishing Fire Zones." Whenever in this Code reference is made to any fire zone, it shall be construed to mean one of the fire zones created by said ordinance. **General**

(b) **Buildings Located in More than One Fire Zone.** A building or structure which is located partly in one fire zone and partly in another shall be considered to be in the more highly restricted fire zone when more than one-third of its total floor area is located in such zone.

(c) **Moved Buildings.** Any building or structure moved within or into any fire zone shall be made to comply with all the requirements for new buildings in that fire zone.

(d) **Temporary Buildings.** Temporary buildings such as reviewing stands and other miscellaneous structures conforming to the requirements of this Code, and sheds, canopies, or fences used for the protection of the public around and in conjunction with construction work may be erected in Fire Zone No. 1 or No. 2 by special permit from the Building Official for a limited period of time, and such building or structure shall be completely removed upon the expiration of the time limit stated in such permit.

(e) **Center Lines of Streets.** For the purpose of this Chapter, the center line of an adjoining street or alley may be considered an adjacent property line. Distance shall be measured at right angles to the street or alley.

Sec. 1602. (a) General. Buildings or structures hereafter erected, constructed, moved within or into Fire Zone No. 1 shall be only of Type I, II, III-H.T., III-one-hour, or IV-one-hour construction and shall meet the requirements of this Section. [For Exceptions covering Type IV-N construction, see Section 1109 and Section 2103 (a).] **Restrictions in Fire Zone No. 1**

(b) **Alterations.** No building of Type IV construction in excess of one thousand square feet (1000 sq. ft.) in floor area nor any building of Type V construction already erected in Fire Zone No. 1 shall hereafter be altered, raised, enlarged, added to, or moved, except as follows:

**Restrictions
in Fire Zone
No. 1
(Continued)**

1. Such Type IV building may be made to conform to all the provisions of Sections 1602 (a) and 2103.

2. Changes, alterations, and repairs to the interior of such building or to the front thereof facing a public street may be made, provided such changes do not, in the opinion of the Building Official, increase the fire hazard of such building.

3. Roofs of such buildings may be covered only with a fire-retardant roofing as specified in Section 3203. See Section 104 (f) for repairs.

4. Such building may be moved entirely outside the limits of Fire Zone No. 1.

5. Such building may be demolished.

(c) **Occupancies Prohibited.** No Group E, Division 2 Occupancy having a floor area exceeding fifteen hundred square feet (1500 sq. ft.) shall be permitted in Fire Zone No. 1.

No Group E, Division 1 or 5 Occupancies shall be permitted in Fire Zone No. 1.

EXCEPTION: This shall not apply to dry cleaning plants not using highly flammable liquids.

**Restrictions
in Fire Zone
No. 2**

Sec. 1603. (a) General. Buildings or structures hereafter erected, constructed, moved within or into Fire Zone No. 2 shall be one of the Types of Construction as defined in this Code and shall meet the requirements of this Section.

For fire-resistive protection of exterior walls and openings, as determined by location on property, see Section 504 and Part V. (For regulations covering open parking garages see Section 1109.)

Roof covering shall be fire-retardant roofing as specified in Section 3203 (e). See Section 104 (f) for repairs.

(b) **Alterations.** No building of Type IV construction in excess of one thousand square feet (1000 sq. ft.) in floor area nor any building of Type V construction already erected in Fire Zone No. 2, shall hereafter be altered, raised, enlarged, added to or moved except as follows:

1. Such building may be made to conform to the provisions of Section 2103 for Type IV and Section 2203 for Type V construction.

2. Changes, alterations, and repairs to the interior of such building or to the front thereof facing a public street may be made provided such changes do not, in the opinion of the Building Official, increase the fire hazard of such building.

3. Roofs of such buildings may be covered only with a fire-retardant roofing as specified in Section 3203. See Section 104 (f) for repairs.

4. Such building may be moved entirely outside the limits of Fire Zone No. 2.

5. Such building may be demolished.

6. Combustible finish on the outside of walls may be replaced by or covered with exterior plaster as specified in Chapter 47.

**Restrictions
in Fire Zone
No. 2
(Continued)**

(c) **Occupancies Prohibited.** No Group E, Division 2 Occupancy having a floor area exceeding fifteen hundred square feet (1500 sq. ft.) shall be permitted in Fire Zone No. 2.

No Group E, Division 1 or 5 Occupancies shall be permitted in Fire Zone No. 2.

EXCEPTION: This shall not apply to dry cleaning plants not using highly flammable liquids.

Sec. 1604. Any building or structure complying with the requirements of this Code may be erected, constructed, moved within or into Fire Zone No. 3.

**Restrictions
in Fire Zone
No. 3**

PART V

REQUIREMENTS BASED ON TYPES OF CONSTRUCTION

CHAPTER 17—CLASSIFICATION OF ALL BUILDINGS BY
TYPES OF CONSTRUCTION AND GENERAL REQUIREMENTS**General**

Sec. 1701. The requirements of Part V are for the various Types of Construction and represent varying degrees of public safety and resistance to fire. Every building shall be classified by the Building Official into one of the Types of Construction set forth in Table No. 17-A. Any building which does not entirely conform to a Type of Construction set forth in Table No. 17-A shall be classified by the Building Official into a type having an equal or lesser degree of fire resistance.

No building or portion thereof shall be required to conform to the details of a Type of Construction higher than that type which meets the minimum requirements based on Occupancy (Part III) or Location in Fire Zone (Part IV) even though certain features of such building actually conform to a higher Type of Construction.

Where specific materials, types of construction, or fire-resistive protection are required, such requirements shall be the minimum requirements and any materials, types of construction, or fire-resistive protection which will afford equal or greater public safety or resistance to fire, as specified in this Code, may be used.

Portions of buildings separated as specified in Section 505 (c) may be considered a separate building for classification of types of construction. When there is no such separation, the area of the entire building shall not exceed the least area permitted for the types of construction involved.

**Structural
Frame**

Sec. 1702. The structural frame shall be considered to be the columns and the girders, beams, trusses, and spandrels having direct connections to the columns and all other members which are essential to the stability of the building as a whole. The members of floor or roof panels which have no connection to the columns shall be considered secondary members and not a part of the structural frame.

**Usable Space
Under Floors**

Sec. 1703. Usable space under the first floor shall be enclosed except in Groups I and J Occupancies and such enclosure when constructed of metal or wood shall be protected on the side of the usable space as required for one-hour fire-resistive construction. Doors shall be self-closing, of incombustible construction or solid wood core, not less than one and three-fourths inches ($1\frac{3}{4}$ ") in thickness.

**Roof
Coverings**

Sec. 1704. Roof covering shall be fire-retardant except in Type V buildings housing Groups H, I, or J Occupancies, where it may be as specified in Section 3203 (f).

Skylights shall be constructed as required in Chapter 34.
 Penthouses shall be constructed as required in Chapter 36.
 For use of plastics in roofs see Chapter 52.

**Roof
 Coverings
 (Continued)**

EXCEPTION: Roofs of cedar or redwood shakes having a nominal thickness of one inch (1") at the butt may be used in buildings of Group F, Division 2, Occupancies of Type V construction, where there are no general requirements for fire resistance, provided that the horizontal clearance between cornice and property line, except street fronts, is not less than ten feet (10'). This provision shall be applicable only in Fire Zone No. 3.

For Attics; Access and Area, see Section 3205. For Roof Drainage, see Section 3206.

Sec. 1705. (a) Partitions. Regardless of the fire-resistive requirements for permanent partitions, temporary partitions dividing portions of stores, offices, or similar places occupied by one tenant only, and which do not establish a corridor serving an occupant load of 30 or more, may be constructed of:

**Unprotected
 Materials
 Allowed**

1. Incombustible materials.
2. Fire-retardant treated wood.
3. One-hour fire-resistive construction.
4. Wood panels or similar light construction up to three-fourths the height of the room in which placed; when more than three-fourths the height of the room, such partitions shall have not less than the upper one-fourth of the partition constructed of glass.

For use of plastics in partitions see Section 5208.

(b) Walls Fronting on Public Ways. Regardless of fire-resistive requirements for exterior walls certain elements of the walls fronting on public ways may be constructed as follows:

1. Show-window frames, aprons and showcases located in the first story may be of combustible or incombustible materials, provided the height of such construction does not exceed fifteen feet (15') above grade.
2. In Fire Zones No. 2 and No. 3 wood veneer of not less than one-inch (1") nominal thickness or Exterior type plywood not less than three-eighths inch ($\frac{3}{8}$ ") nominal thickness may be applied to walls provided the veneer does not exceed one story in height and further provided such wood shall be placed either directly against incombustible surfaces or furred out from such surfaces not to exceed one and five-eighths inches ($1\frac{5}{8}$ ") with all concealed spaces firestopped as provided in Section 2508.

(c) Trim. Trim, picture molds, chair rails, baseboards, handrails, show-window backing may be of wood. Unpro-

TABLE NO. 17-A—TYPES OF CONSTRUCTION—FIRE-RESISTIVE REQUIREMENTS
(In Hours)

(For Details see Chapters under Occupancy and Types of Construction)

MATERIALS OF CONSTRUCTION	I	II	III		IV		V	
	Incom- bustible	Incom- bustible	1-Hr. or H.T.	N	1-Hour	N	1-Hour	N
			Combustible		Incombustible		Combustible	
Exterior Bearing Walls	4 Sec. 1803 (a)	4 Sec. 1903 (a)	4 Sec. 2003 (a)	4 Sec. 2003 (a)	1	N	1	N
Interior Bearing Walls	3	1	1	N	1	N	1	N
Exterior Non-bearing Walls	4 Sec. 1803 (a)	4 Sec. 1903 (a)	4 Sec. 2003 (a)	4 Sec. 2003 (a)	1	N	1	N
Structural Frame ¹	3	2	1 or H.T.	N	1	N	1	N
Partitions— Permanent	1 ²	1 ²	1 or H.T.	N	1 ²	N	1	N
Vertical Openings	2	2	1 or H.T.	1	1	1	1 Sec. 1706	1 Sec. 1706
Floors	2	1	1 or H.T.	N	1	N	1	N
Roofs	2 Sec. 1806	1 Sec. 1906	1 or H.T.	N	1 Sec. 2106	N	1	N
Exterior Doors and Windows	Sec. 1803 (b)	Sec. 1903 (b)	Sec. 2003 (b)	Sec. 2003 (b)	Sec. 2103 (b)	Sec. 2103 (b)	Sec. 2203 (b)	Sec. 2203 (b)

N—No general requirements for fire resistance. H.T.—Heavy Timber.

¹Structural frame elements in the exterior wall shall be protected against external fire exposure as required for exterior bearing walls or the structural frame whichever is greater.²Fire-retardant treated wood (see Section 407) may be used in the assembly provided fire resistance requirements are maintained. See Sections 1801, 1901 and 2101 respectively.

tected wood doors and windows may be used except where openings are required to be fire protected.

Materials used for interior finish of walls and ceilings, including wainscoting, shall be as specified in Chapter 42.

(d) **Loading Platforms.** Exterior loading platforms may be of incombustible construction or heavy timber construction with wood floors not less than two inches (2") nominal thickness. Such wood construction shall not be carried through the exterior walls.

(e) **Insulating Boards.** Combustible insulating boards may be used under finished flooring.

Sec. 1706. (a) **General.** Enclosure for elevator shafts, vent shafts and other vertical openings shall be as set forth in Table No. 17-A and all exterior openings therein shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating and all interior openings shall be protected by a fire assembly having a one-hour fire-resistive rating except as set forth in Table No. 33-B. (See Chapter 30.)

**Unprotected
Materials
Allowed
(Continued)**

**Enclosure
of Vertical
Openings**

EXCEPTION: In Type V buildings, chutes and dumb-waiter shafts with a cross-sectional area of not more than nine square feet (9 sq. ft.) may be lined with approved incombustible materials covered with not less than No. 26 U. S. gauge sheet metal with all joints in such sheet metal lapped. All openings into any such vertical enclosure shall be protected by metal or metal-clad doors with either metal or metal-clad jambs, casings, or frames.

(b) **Construction.** Exit enclosures shall be constructed as specified in Sections 3308 and 3309.

(c) **Guardrail.** A parapet wall, or handrail, which is at least thirty-six inches (36") in height shall be provided around all open shaft enclosures extending through the roof.

Sec. 1707. (a) **Building Paper.** Asphalt-saturated felt free from holes and breaks and weighing not less than 14 pounds per one hundred square feet (100 sq. ft.) or approved waterproof paper, shall be applied over studs or sheathing of all exterior walls. Such felt or paper shall be applied weather-board fashion, lapped not less than two inches (2") at horizontal joints and not less than six inches (6") at vertical joints.

**Weather
Protection**

Building paper may be omitted in the following cases:

1. When exterior covering is of approved weatherproof panels.
2. In back-plastered construction.
3. When there is no human occupancy.
4. Over water-repellent panel sheathing.
5. Under approved paperbacked metal or wire fabric lath.

**Weather
Protection
(Continued)**

6. Under metal lath, wire lath, or wire fabric lath on incombustible construction.

(b) **Flashing and Counterflashing.** Exterior openings exposed to the weather shall be flashed in such a manner as to make them weatherproof.

All parapets shall be provided with coping of approved materials. All flashing, counterflashing, and coping when of metal shall be of not less than No. 26 U. S. gauge corrosion-resistant metal.

**Members
Carrying
Masonry
or Concrete**

Sec. 1708. All members carrying masonry or concrete walls in buildings over one story in height shall be fire-protected with not less than one-hour fire protection.

EXCEPTION: Fire protection may be omitted from the bottom flange of lintels, shelf angles, or plates that are not a part of the structural frame.

Parapets

Sec. 1709. (a) General. Parapet walls shall have the same fire resistance as required for the exterior walls.

(b) **Fire Zone Location.** Parapet walls not less than thirty inches (30") in height shall be provided on exterior walls of buildings located in Fire Zones No. 1 and No. 2 when the walls are required to be fire-resistive due to their location on the property.

Parapet walls not less than twelve inches (12") in height shall be provided on exterior walls of buildings located in Fire Zone No. 3 when the walls are required to be fire-resistive due to their location on the property.

EXCEPTIONS: Parapets are not required due to fire zone location on the following walls:

1. When the roof construction is entirely incombustible.
2. When the roof has an angle of more than 20 degrees with horizontal.
3. On buildings twenty feet (20') or less in height.

(c) **Climatic Location.** Parapet walls not less than twelve inches (12") in height shall be provided on exterior walls located less than five feet (5') from a property line where temperatures normally fall below freezing.

EXCEPTION: Parapets are not required due to climatic location for Group J Occupancies accessory to single-family dwellings.

Cornices

Sec. 1710. Except in Type V construction, cornices, architectural projections, and similar appendages shall be constructed of substantial incombustible materials and when over public property as specified in Chapter 45.

Eave overhangs, extending over public property, shall be constructed as specified in Chapter 45. Other eave overhangs, extending beyond walls required to be fire-resistive, shall be of incombustible material or one-hour fire-resistive construction. Eaves over required windows shall be not less than thirty inches (30") from the side and rear property lines.

**Cornices
(Continued)**

Sec. 1711. (a) Floors and Walls. The floors and walls of public toilet compartments in Groups A through H Occupancies, and those within two feet (2') of the front and sides of urinals, shall be finished with a smooth hard non-absorbent surface of cement, tile, or approved equal. Walls shall be so finished to a height of four feet (4') above the floor. Materials other than structural elements used in such walls shall be of a type which is not adversely affected by moisture.

**Toilet
Compartments
and Showers**

Each water closet compartment shall be not less than thirty inches (30") in width.

(b) **Shower Areas.** Showers shall be finished as specified in Subsection (a) to a height of not less than six feet (6'). Materials other than structural elements used in such walls shall be of a type which is not adversely affected by moisture.

(c) **Doors and Panels.** Doors and panels of shower and bathtub enclosures shall be substantially constructed from approved shatter-resistant materials. Hinged shower doors shall open outward.

(d) **Glass.** Glass used in doors and panels of shower and bathtub enclosures shall be not less than seven-thirty-seconds inch ($\frac{7}{32}$ ") in thickness and shall be an approved type of wire reinforced, tempered or laminated safety glass.

(e) **Plastics.** Plastics used in doors and panels of shower and bathtub enclosures shall be of a shatter-resistant type.

Sec. 1712. Gas and electric ranges or hot plates shall have clearances from combustible material, and ventilation in accordance with Section 5109, Subsections (a) and (b).

**Clearances
for
Electric
Ranges
and Hot
Plates**

CHAPTER 18—TYPE I BUILDINGS

Definition

Sec. 1801. The structural elements in Type I Buildings shall be of steel, iron, concrete, or masonry.

Walls and permanent partitions shall be of incombustible fire-resistive construction except that permanent nonbearing partitions of one-hour fire-resistive construction may use fire retardant treated wood (see Section 407) within the assembly.

Materials of construction and fire-resistive requirements shall be as specified in Chapter 17.

Structural Framework

Sec. 1802. Structural framework shall be of structural steel or iron as specified in Chapter 27, reinforced concrete as in Chapter 26, or reinforced masonry as in Chapter 24.

For additional requirements for Group E Occupancies, see Section 1002 (b).

Exterior Walls and Openings

Sec. 1803. (a) **Exterior Walls.** Exterior walls and all structural members shall comply with the requirements specified in Section 504 and the fire-resistive provisions set forth in Table No. 17-A.

EXCEPTIONS: 1. Nonbearing walls fronting on streets or yards having a width of at least fifty feet (50') in Fire Zone No. 1 or forty feet (40') in Fire Zone No. 2 or No. 3 may be of unprotected incombustible construction.

2. In Groups F, G, and H Occupancies exterior bearing walls may be two-hour fire-resistive where openings are permitted.

3. In other than Group E Occupancies exterior nonbearing walls may be of one-hour fire-resistive construction where unprotected openings are permitted and two-hour fire-resistive construction where fire protection of openings is required.

(b) **Openings in Walls.** All openings in exterior walls shall conform to the requirements of Section 504 (b) and shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating when they are less than twenty feet (20') from an adjacent property line or the center line of a street or public space.

No openings shall be permitted in exterior walls of Groups A, B, C, D, E, and F Occupancies less than five feet (5') from the property line, and no openings in Groups G, H, I, and J Occupancies less than three feet (3') from the property line.

Floors

Sec. 1804. (a) **Wood Sleepers.** Where wood sleepers are used for laying wood flooring on masonry or concrete fire-resistive floors the space between the floor slab and the underside of the wood flooring shall be filled with incombustible material or firestopped in such a manner that there will be no

open spaces under the flooring which will exceed one hundred square feet (100 sq. ft.) in area and such space shall be filled solidly under all permanent partitions so that there is no communication under the flooring between adjoining rooms.

Floors
(Continued)

(b) **Mezzanine Floors.** Mezzanine floors may be of wood or unprotected steel except that in Fire Zone No. 1 they shall be of incombustible materials as approved for one-hour fire-resistive construction or of heavy timber construction as specified for floors in Section 2514 (b).

Not more than two mezzanine floors shall be in any room of a building.

No mezzanine floor or floors shall cover more than 33½ per cent of the area of any room.

Sec. 1805. Stairs and stair platforms shall be constructed of reinforced concrete, iron, or steel with treads and risers of concrete, iron, or steel. Brick, marble, tile, or other hard incombustible materials may be used for the finish of such treads and risers.

Stair
Construction

Stairs shall be designed and constructed as specified in Chapter 33.

Sec. 1806. Roofs more than twenty-five feet (25') above any floor, balcony, or gallery may be of unprotected incombustible materials.

Roofs

Where every part of the structural steel framework of the roof of a Group A, B, or C Occupancy is not less than twenty-five feet (25') above any floor, balcony, or gallery, fire protection of all members of the roof construction may be omitted.

Where every part of the structural steel framework of the roof of a Group A, B, or C Occupancy is more than eighteen feet (18') and less than twenty-five feet (25') above any floor, balcony, or gallery, the roof construction shall be protected by a ceiling of not less than one-hour fire-resistive construction.

Roofs may be sheathed by wood planks of two and one-half-inch (2½") nominal thickness when such sheathing is more than thirty feet (30') distant from any floor, balcony, or gallery and when such plank sheathing is protected on the underside by a ceiling of not less than one-hour fire-resistive construction.

Roof covering shall be a fire-retardant roofing as specified in Section 3203.

CHAPTER 19—TYPE II BUILDINGS

Definition

Sec. 1901. The structural elements in Type II Buildings shall be of steel, iron, concrete, or masonry.

Walls and permanent partitions shall be of incombustible fire-resistive construction except that permanent nonbearing partitions of one-hour fire-resistive construction may use fire retardant treated wood (see Section 407) within the assembly.

Materials of construction and fire-resistive requirements shall be as specified in Chapter 17.

Structural Framework

Sec. 1902. Structural framework shall be of structural steel or iron as specified in Chapter 27, reinforced concrete as in Chapter 26, or reinforced masonry as in Chapter 24.

Exterior Walls and Openings

Sec. 1903. (a) **Exterior Walls.** Exterior walls and all structural members shall comply with the requirements specified in Section 504 and the fire-resistive provisions set forth in Table No. 17-A.

EXCEPTIONS: 1. Nonbearing walls fronting on streets or yards having a width of at least fifty feet (50') in Fire Zone No. 1 or forty feet (40') in Fire Zone No. 2 or No. 3 may be of unprotected incombustible construction.

2. In Groups F, G, and H Occupancies exterior bearing walls may be two-hour fire-resistive where openings are permitted.

3. In other than Group E Occupancies exterior nonbearing walls may be of one-hour fire-resistive construction where unprotected openings are permitted and two-hour fire-resistive construction where fire protection of openings is required.

(h) **Openings in Walls.** All openings in exterior walls shall conform to the requirements of Section 504 (b) and shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating when they are less than twenty feet (20') from an adjacent property line or the center line of a street or public space.

No openings shall be permitted in exterior walls of Groups A, B, C, D, E, and F Occupancies less than five feet (5') from the property line, and no openings in Groups G, H, I, and J Occupancies less than three feet (3') from the property line.

Floors

Sec. 1904. (a) **General.** Where wood sleepers are used for laying wood flooring on masonry or concrete fire-resistive floors, the space between the floor slab and the underside of the wood flooring shall be filled with incombustible material or firestopped in such a manner that there will be no open

spaces under the flooring which will exceed one hundred square feet (100 sq. ft.) in area; and such space shall be filled solidly under all permanent partitions so that there is no communication under the flooring between adjoining rooms.

Floors
(Continued)

(b) **Mezzanine Floors.** Mezzanine floors may be of wood or unprotected steel except that in Fire Zone No. 1 they shall be of incombustible materials as approved for one-hour fire-resistive construction or of heavy timber construction as specified for floors in Section 2514 (b).

Not more than two mezzanine floors shall be in any room of a building.

No mezzanine floor or floors shall cover more than 33½ per cent of the area of any room.

Sec. 1905. Stairs and stair platforms shall be constructed of reinforced concrete, iron, or steel with treads and risers of concrete, iron, or steel. Brick, marble, tile, or other hard incombustible materials may be used for the finish of such treads and risers.

Stair
Construction

Stairs shall be designed and constructed as specified in Chapter 33.

Sec. 1906. Roofs more than twenty-five feet (25') above any floor, balcony, or gallery may be of unprotected incombustible materials.

Roofs

Where every part of the structural steel framework of the roof of a Group A, B, or C Occupancy is not less than twenty-five feet (25') above any floor, balcony, or gallery, fire protection of all members of the roof construction may be omitted.

Where the structural steel framework of the roof of a Group A, B, or C Occupancy is more than eighteen feet (18') and less than twenty-five feet (25') above any floor, balcony, or gallery, the roof construction shall be protected by a ceiling of not less than one-hour fire-resistive construction.

Roofs may be sheathed by wood planks of two and one-half-inch (2½") nominal thickness when such sheathing is more than thirty feet (30') distant from any floor, balcony, or gallery and when such plank sheathing is protected on the underside by a ceiling of not less than one-hour fire-resistive construction.

Roof covering shall be a fire-retardant roofing as specified in Section 3203.

CHAPTER 20—TYPE III BUILDINGS

Definition

Sec. 2001. Structural elements of Type III Buildings may be of any materials permitted by this Code.

Type III, One-Hour buildings shall be one-hour fire-resistive construction throughout.

Type III, Heavy Timber buildings shall be Heavy Timber Construction as provided in Section 2514.

Exterior walls shall be of incombustible fire-resistive construction.

Materials of construction and fire-resistive requirements shall be as specified in Chapter 17.

For requirements due to occupancy, see Chapters 6 to 15, inclusive.

For requirements in Fire Zones see Chapter 16.

Structural Framework

Sec. 2002. Structural framework shall be of steel or iron as specified in Chapter 27, concrete as in Chapter 26, masonry as in Chapter 24, or wood as in Chapter 25 and this Chapter.

Exterior Walls, Openings, and Partitions

Sec. 2003. (a) Exterior Walls. Exterior walls and all structural members shall comply with the requirements specified in Section 504 and the fire-resistive provisions set forth in Table No. 17-A.

EXCEPTIONS: 1. Nonbearing walls fronting on streets or yards having a width of at least fifty feet (50') in Fire Zone No. 1 or forty feet (40') in Fire Zone No. 2 or No. 3 may be of unprotected incombustible construction.

2. In Groups F, G, and H Occupancies exterior bearing walls may be two-hour fire-resistive where openings are permitted.

3. In other than Group E Occupancies exterior nonbearing walls may be of one-hour fire-resistive construction where unprotected openings are permitted and two-hour fire-resistive construction where fire protection of openings is required.

4. Bulkheads, not more than thirty inches (30") high below show windows, need not be of incombustible or fire-resistive material.

5. Wood columns and arches conforming to heavy timber sizes may be used externally where exterior walls are permitted to be of unprotected incombustible construction or one-hour fire-resistive construction.

(b) Openings in Walls. All openings in exterior walls shall conform to the requirements of Section 504 (b) and shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating when they are less than twenty feet (20') from an adjacent property line or the center line of a street or public space.

No openings shall be permitted in exterior walls of Groups A, B, C, D, E and F Occupancies less than five feet (5') from the property line, and no openings in Groups G, H, I and J Occupancies less than three feet (3') from the property line.

**Exterior
Walls,
Openings, and
Partitions
(Continued)**

(c) **Partitions.** Permanent partitions in Type III, One-Hour buildings shall be of one-hour fire-resistive construction. In Type III Heavy Timber buildings they shall be of solid wood construction formed by not less than two layers of one-inch (1") nominal matched boards or laminated construction of four-inch (4") nominal thickness or of one-hour fire-resistive construction. Bearing partitions when constructed of wood shall not support more than two stories and a roof. Partitions shall be constructed as specified in Section 2507 (e).

Sec. 2004. (a) General. Floors may be constructed as specified in Chapter 26 for concrete, Chapter 24 for masonry, Chapter 25 for wood, and Chapter 27 for steel or iron.

Floors

Wood joists, beams, and girders supported by masonry walls shall be anchored thereto as specified in Section 2313. Ventilation shall be provided between the ground and a wood floor as specified in Section 2517.

(b) **Heavy Timber Floors.** Heavy timber floors shall be constructed as specified in Section 2514.

(c) **Wood Sleepers.** Where wood sleepers are used for laying wood flooring on masonry or concrete fire-resistive floors, the space between the floor slab and the underside of the wood flooring shall be filled with incombustible material or firestopped in such a manner that there will be no open spaces under the flooring which will exceed one hundred square feet (100 sq. ft.) in area; and such space shall be filled solidly under all partitions so that there is no communication under the flooring between adjoining rooms.

(d) **Mezzanine Floors.** Mezzanine floors in Fire Zone No. 1 shall be constructed of not less than one-hour fire-resistive construction or of heavy timber construction, as specified for floors in Section 2514.

Not more than two mezzanine floors shall be in any room of a building.

No mezzanine floor or floors shall cover more than 33 1/3 per cent of the area of any room.

Sec. 2005. Stairs may be constructed with any material allowed in this Code except that in heavy timber buildings stairs shall be constructed with wood treads and risers of not less than two-inch (2") nominal thickness, except where built on laminated or plank inclines as required for floors, when

**Stair
Construction**

**Stair
Construction
(Continued)**

they may be of one-inch (1") nominal thickness or may be constructed as required in Type I buildings.

In buildings four or more stories in height, stairs and stair construction shall be as required for Type I buildings.

Stairs and exits shall be designed and constructed as specified in Chapter 33.

Roofs

Sec. 2006. Heavy timber roofs shall be constructed as specified in Section 2514. Wood joists, beams, and girders supported by masonry walls shall be anchored thereto as specified in Section 2313.

Roof covering shall be a fire-retardant roofing as specified in Section 3203.

CHAPTER 21—TYPE IV BUILDINGS

Sec. 2101. The structural elements of Type IV Buildings shall be of incombustible materials. **Definition**

Type IV, One-Hour buildings shall be of incombustible construction and one-hour fire-resistive throughout except that permanent nonbearing partitions may use fire retardant treated wood (see Section 407) within the assembly, provided fire-resistive requirements are maintained.

Walls and permanent partitions shall be of incombustible materials.

Materials of construction and fire-resistive requirements shall be as specified in Chapter 17.

For requirements due to occupancy, see Chapters 6 to 15, inclusive.

For requirements in Fire Zones see Chapter 16.

Sec. 2102. Structural framework shall be as specified in Chapter 27 for iron and steel, Chapter 26 for concrete, and Chapter 24 for masonry. **Structural Framework**

Sec. 2103. (a) **Exterior Walls.** For fire protection of exterior walls and openings as determined by location on property, see Section 504 and Table No. 5-A: **Exterior Walls and Openings**

EXCEPTIONS: 1. A fire-resistive time period will not be required for an exterior wall of a one-story Type IV building housing a Group F, G or J Occupancy provided the floor area of the building does not exceed twenty-five hundred square feet (2500 sq. ft.) and such wall is located not less than twenty feet (20') from a property line in Fire Zone No. 1 and ten feet (10') from a property line in Fire Zone No. 2.

2. In Fire Zone No. 2 a fire-resistive time period will not be required for an exterior wall of a Type IV building housing a Group F, G or J Occupancy provided such wall is located not less than twenty feet (20') from a property line.

3. In Fire Zone No. 2 or No. 3 a fire-resistive time period will not be required for an exterior wall of a one-story Type IV building housing a Group F, G or J Occupancy provided the floor area of the building does not exceed six hundred square feet (600 sq. ft.) and such wall is located not less than three feet (3') from a property line.

(b) **Openings in Walls.** All openings in exterior walls shall conform to the requirements specified in Section 504.

EXCEPTION: This shall not apply to openings which are more than twenty feet (20') from the center line of the street or public space.

**Exterior
Walls and
Openings
(Continued)**

In Fire Zone No. 1 all openings in the exterior walls within twenty feet (20') of a property line shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating.

In Fire Zone No. 2 all openings not on a street front and which are within ten feet (10') of an adjacent property line shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating.

**Floor
Construction**

Sec. 2104. Floor construction shall be of incombustible material, provided, however, that a wood surface or finish may be applied over such incombustible material.

**Stair
Construction**

Sec. 2105. Stairs shall be of any type permitted by this Code and shall comply with the requirements of Chapter 33.

**Roof
Construction**

Sec. 2106. Roofs shall be of incombustible construction. In Type IV, One-Hour buildings, roofs may be as specified in Section 1806.

Roof covering shall be a fire-retardant roofing as specified in Section 3203.

CHAPTER 22—TYPE V BUILDINGS

Sec. 2201. Type V Buildings may be of any materials allowed by this Code. **Definition**

Type V, One-Hour buildings shall be of one-hour fire-resistive construction throughout.

Materials of construction and fire-resistive requirements shall be as specified in Chapter 17.

For requirements due to occupancy, see Chapters 6 to 15, inclusive.

For requirements in Fire Zones, see Chapter 16.

Sec. 2202. Type V buildings three stories in height shall have all exterior walls of the first story covered with solid sheathing as specified in this Section. Such sheathing, when of wood, shall be applied diagonally. **Sheathing**

Sheathing shall be one or more of the following materials:

Wood not less than five-eighths inch ($\frac{5}{8}$ ") thick.

Fiberboard not less than seven-sixteenths inch ($\frac{7}{16}$ ") thick complying with U.B.C. Standard No. 22-1-64.

Gypsum sheathing not less than one-half inch ($\frac{1}{2}$ ") thick complying with U.B.C. Standard No. 22-2-64.

Plywood not less than five-sixteenths inch ($\frac{1}{8}$ ") thick complying with U.B.C. Standard No. 25-9-64.

Sec. 2203. (a) **Exterior Walls.** For fire protection of exterior walls and openings as determined by location on property, see Section 504 and Table No. 5-A. **Exterior Walls and Openings**

EXCEPTION: In Fire Zone No. 2 exterior walls fronting on streets or yards having a width of at least forty feet (40') may be of unprotected construction.

(b) **Openings in Walls.** All openings in exterior walls shall conform to the requirements specified in Section 504. In Fire Zone No. 2 all openings not on a street front and which are within ten feet (10') of an adjacent property line shall be protected by a fire assembly having a three-fourths-hour fire-resistive rating.

For enclosure of vertical openings, see Section 1706.

Sec. 2204. Stair construction may be of any type permitted in this Code and shall conform to the requirements of Chapter 33. **Stair Construction**

PART VI

ENGINEERING REGULATIONS—QUALITY AND DESIGN
OF THE MATERIALS OF CONSTRUCTION

CHAPTER 23—LIVE AND DEAD LOADS

Definitions

Sec. 2301. The following definitions give the meaning of certain terms as used in this Chapter:

DEAD LOAD. The dead load of a building shall include the weight of the walls, permanent partitions, framing, floors, roofs, and all other permanent stationary construction entering into and becoming a part of a building.

LIVE LOAD. The live load includes all loads except dead and lateral loads.

Loads

Sec. 2302. (a) **General.** Buildings and all parts thereof shall be of sufficient strength to support the estimated or actual imposed dead and live loads in addition to their own proper dead load, without exceeding the stresses noted elsewhere in this Code, provided that no building or part thereof shall be designed for live loads less than those specified in this Chapter. Impact shall be considered in the design of any structure where impact loads occur.

(b) **Special.** Provisions shall be made in designing office floors for a load of 2000 pounds placed upon any space two and one-half feet ($2\frac{1}{2}'$) square wherever this load upon an otherwise unloaded floor would produce stresses greater than those caused by a uniformly distributed load of 50 pounds per square foot.

In designing floors to be used for industrial or commercial purposes, the actual live load caused by the use to which the building or part of the building is to be put shall be used in the design of such building or part thereof, and special provision shall be made for machine or apparatus loads when such machine or apparatus would cause a greater load than specified for such use in Section 2304.

Floors in office buildings and in other buildings, where partition locations are subject to change, shall be designed to support, in addition to all other loads, a uniformly distributed load equal to 20 pounds per square foot.

Public garages and commercial or industrial buildings in which loaded trucks are placed, used, or stored shall have the floor systems designed to support a concentrated rear wheel load of a loaded truck placed in any possible position.

**Method
of Design**

Sec. 2303. Any system or method of construction to be used shall admit of a rational analysis in accordance with well-established principles of mechanics.

For requirements for plastic design, see Section 2701.

All allowable stresses and soil-bearing values specified in this Code may be increased one-third due to wind or earthquake either acting alone or when combined with vertical loads. No increase shall be allowed for vertical loads acting alone.

Wind and earthquake loads need not be assumed to act simultaneously.

Sec. 2304. The unit loads set forth in Table No. 23-A shall be taken as the minimum live loads in pounds per square foot

Method
of Design
(Continued)

Unit
Live
Loads

TABLE NO. 23-A—UNIT LIVE LOADS

OCCUPANCY	LOAD IN POUNDS PER SQUARE FOOT OF HORIZONTAL PROJECTION
Apartments	40
Armories	150
Auditoriums—Fixed Seats.....	50
Movable Seats	100
Balconies and Galleries—Fixed Seats.....	50
Movable Seats	100
Cornices	60
Corridors, Public	100
Dance Halls	100
Drill Rooms	100
Dwellings	40
Exterior Balconies.....	100
Fire Escapes.....	100
Garages—Storage or Repair.....	100
Garages—Storage Private Pleasure Cars.....	50
Gymnasiums	100
Hospitals—Wards and Rooms.....	40
Hotels—Guest Rooms and Private Corridors.....	40
Libraries—Reading Rooms.....	60
Stack Rooms.....	125
Loft Buildings	100
Manufacturing—Light	75
Heavy	125
Marquees	60
Offices	50
Printing Plants—Press Rooms.....	150
Composing and Linotype Rooms.....	100
Public Rooms.....	100
Rest Rooms.....	50
Reviewing Stands and Bleachers.....	100
Roof Loads..... (See Section 2305)	
Schools—Classrooms	40
Sidewalks	250
Skating Rinks.....	100
Stairways	100
Storage—Light	125
Heavy (Load to be determined from proposed use or occupancy, but never less than).....	250
Stores—Retail (Light Merchandise).....	75
Wholesale (Light Merchandise).....	100

**Unit
Live
Loads
(Continued)**

of horizontal projection to be used in the design of buildings for the occupancies listed, and loads at least equal shall be assumed for uses not listed in this Section but which create or accommodate similar loadings.

All ceiling joists shall be designed for not less than 10 pounds per square foot total load.

All balcony railings and stair handrails shall be designed to withstand a horizontal force of 20 pounds per lineal foot, applied at the top of the railing.

**Roof
Loads**

Sec. 2305. (a) General. Roofs shall sustain, within the stress limitations of this Code, all "dead loads" plus unit "live loads" as set forth in Table No. 23-B. The live loads shall be assumed to act vertically upon the area projected upon a horizontal plane.

(b) **Unbalanced Loading.** Unbalanced loads shall be used where such loading will result in larger members or connections. Trusses and arches shall be designed to resist the stresses caused by unit live loads on one-half of the span if such loading results in reverse stresses, or stresses greater in any portion than the stresses produced by the required unit live load upon the entire span. For roofs whose structure is composed of a stressed shell, framed or solid, wherein stresses caused by any point loading are distributed throughout the area of the shell, the requirements for unbalanced unit live load design may be reduced 50 per cent.

(c) **Snow Loads.** Snow load, full or unbalanced, shall be considered in place of loads as set forth in Table No. 23-B

TABLE NO. 23-B—ROOF LIVE LOADS—POUNDS PER SQUARE FOOT¹

ROOF SLOPE	TRIBUTARY LOADED AREA IN SQUARE FEET FOR ANY STRUCTURAL MEMBER		
	0 TO 200	201 TO 600	OVER 600
Flat or rise less than 4 inches per foot. Arch or dome with rise less than $\frac{1}{8}$ of span.	20	16	12
Rise 4 inches per foot to less than 12 inches per foot. Arch or dome with rise $\frac{1}{8}$ of span to less than $\frac{3}{8}$ of span.	16	14	12
Rise 12 inches per foot and greater. Arch or dome with rise $\frac{3}{8}$ of span or greater.	12	12	12

¹Where snow loads occur, the roof structure shall be designed for such loads as determined by the Building Official.

where such loading will result in larger members or connections. When valleys are formed by a multiple series of roofs, special provisions shall be made for the increased load at the intersections. Where snow loads occur, the snow loads shall be determined by the Building Official.

**Roof
Loads
(Continued)**

(d) **Reduction of Snow Loads.** Snow loads in excess of 20 pounds per square foot may be reduced for each degree of pitch over 20 degrees by $S/40$ minus $\frac{1}{2}$, where "S" is the total snow load in pounds per square foot. When the shape of roof structure as determined by actual test or experience indicates lesser or greater snow-retention value the roof load shall be modified as approved by the Building Official.

(e) **Special-purpose Roofs.** Roofs to be used for special purposes shall be designed for appropriate loads as approved by the Building Official.

Greenhouses, lath houses, patio structures and agricultural buildings shall be designed for a vertical live load of not less than 10 pounds per square foot.

(f) **Camber.** All roofs shall be designed with sufficient slope or camber to assure adequate drainage after the long-time deflection from dead load or shall be designed to support maximum loads including possible ponding of water due to deflection. See Section 2307 for deflection criteria.

Sec. 2306. The following reductions in unit live loads as set forth in Table No. 23-A for floors shall be permitted in the designing of columns, piers, walls, foundations, trusses, beams, and flat slabs.

**Reduction
of Live Loads**

Except for places of public assembly, and except for live loads greater than 100 pounds per square foot, the design live load on any member supporting one hundred and fifty square feet (150 sq. ft.) or more may be reduced at the rate of 0.08 per cent per square foot of area supported by the member. The reduction shall not exceed 60 per cent nor "R" as determined by the following formula:

$$R = 23.1 \left(1 + \frac{D}{L} \right)$$

WHERE:

R = Reduction in per cent

D = Dead load per square foot of area supported by the member

L = Unit live load per square foot of area supported by the member

For storage live loads exceeding 100 pounds per square foot, no reduction shall be made except that design live loads on columns may be reduced 20 per cent.

Deflection

Sec. 2307. The deflection of any structural member shall not exceed the values set forth in Table No. 23-C, based upon the factors set forth in Table No. 23-E. The deflection criteria representing the most restrictive condition shall apply. Deflection criteria for materials not specified shall be developed in a manner consistent with the provisions of this Section. See Section 2305 (f) for camber requirements.

Wind Pressure

Sec. 2308. (a) General. Buildings or structures shall be designed to withstand the minimum horizontal and uplift pressures set forth in Table No. 23-E and this Section allowing for wind from any direction. The wind pressures set forth in Table No. 23-E are minimum values and shall be adjusted by the Building Officials for areas subjected to higher wind pressures. When the form factor, as determined by wind tunnel tests or other recognized methods, indicates vertical or horizontal loads of lesser or greater severity than those produced by the loads herein specified, the structure may be designed accordingly.

(b) Horizontal Wind Pressure. For purposes of design, the wind pressure shall be taken upon the gross area of the vertical projection of that portion of the building or structure measured above the average level of the adjoining ground.

(c) Uplift Wind Pressure. Roofs of all enclosed buildings or structures shall be designed and constructed to withstand pressures acting upward normal to the surface equal to three-fourths of the values set forth in Table No. 23-E for the height zone under consideration. An enclosed building shall be defined as a building enclosed at the perimeter with solid exterior walls. Openings are permitted in the solid exterior wall provided they are glazed or protected with door assemblies.

Roofs of unenclosed buildings, roof overhangs, architectural projections, eaves, canopies, cornices, marquees, or similar structures unenclosed on one or more sides shall be designed and constructed to withstand upward pressures equal to one and one-fourth times those values set forth in Table No. 23-E.

The upward pressures shall be assumed to act over the entire roof area.

(d) Roofs with Slopes Greater than 30 Degrees. Roofs or sections of roofs with slopes greater than 30 degrees shall be designed and constructed to withstand pressures, acting inward normal to the surface, equal to those specified for the height zone in which the roof is located, and applied to the windward slope only.

(e) Anchorage Requirements. Adequate anchorage of the roof to walls and columns, and of walls and columns to the foundations to resist overturning, uplift, and sliding, shall be provided in all cases.

**TABLE NO. 23-C—MAXIMUM ALLOWABLE DEFLECTION
FOR STRUCTURAL MEMBERS¹**

TYPE OF MEMBER	MEMBER LOADED WITH LIVE LOAD ONLY (L.L.)	MEMBER LOADED WITH LIVE LOAD PLUS DEAD LOAD (L.L. + K D.L.)
Roof Member Supporting Plaster or Floor Member	$L/360$	$L/240$

¹Sufficient slope or camber shall be provided for flat roofs in accordance with Section 2305 (f).

L.L. = Live load

D.L. = Dead load

K = Factor as determined by Table No. 23-D

L = Length of member in same units as deflection

TABLE NO. 23-D—VALUE OF "K"

WOOD		REINFORCED CONCRETE			STEEL
Unseasoned	Seasoned ¹	A's = 0	A's = 0.5 A _s	A's = A _s	
1.0	0.5	2.0	1.2	0.8	0

¹Seasoned lumber is lumber having a moisture content of less than 16 per cent at the time of installation and used under dry conditions of use such as in most covered structures.

A's = Area of compressive reinforcing steel in flexural members.

A_s = Area of tensile reinforcing steel in flexural members.

**TABLE NO. 23-E—WIND PRESSURES FOR VARIOUS HEIGHT ZONES
ABOVE GROUND¹**

HEIGHT ZONES (in feet)	WIND-PRESSURE-MAP AREAS (pounds per square foot)						
	20	25	30	35	40	45	50
Less than 30	15	20	25	25	30	35	40
30 to 49	20	25	30	35	40	45	50
50 to 99	25	30	40	45	50	55	60
100 to 499	30	40	45	55	60	70	75
500 to 1199	35	45	55	60	70	80	90
1200 and over	40	50	60	70	80	90	100

¹See Figure No. 1. Wind pressure column in the table should be selected which is headed by a value corresponding to the minimum permissible, resultant wind pressure indicated for the particular locality.

The figures given are recommended as minimum. These requirements do not provide for tornadoes.

**TABLE NO. 23-F—MULTIPLYING FACTORS FOR WIND PRESSURES—
CHIMNEYS, TANKS, AND SOLID TOWERS**

HORIZONTAL CROSS SECTION	FACTOR
Square or rectangular	1.00
Hexagonal or octagonal	0.80
Round or elliptical	0.60

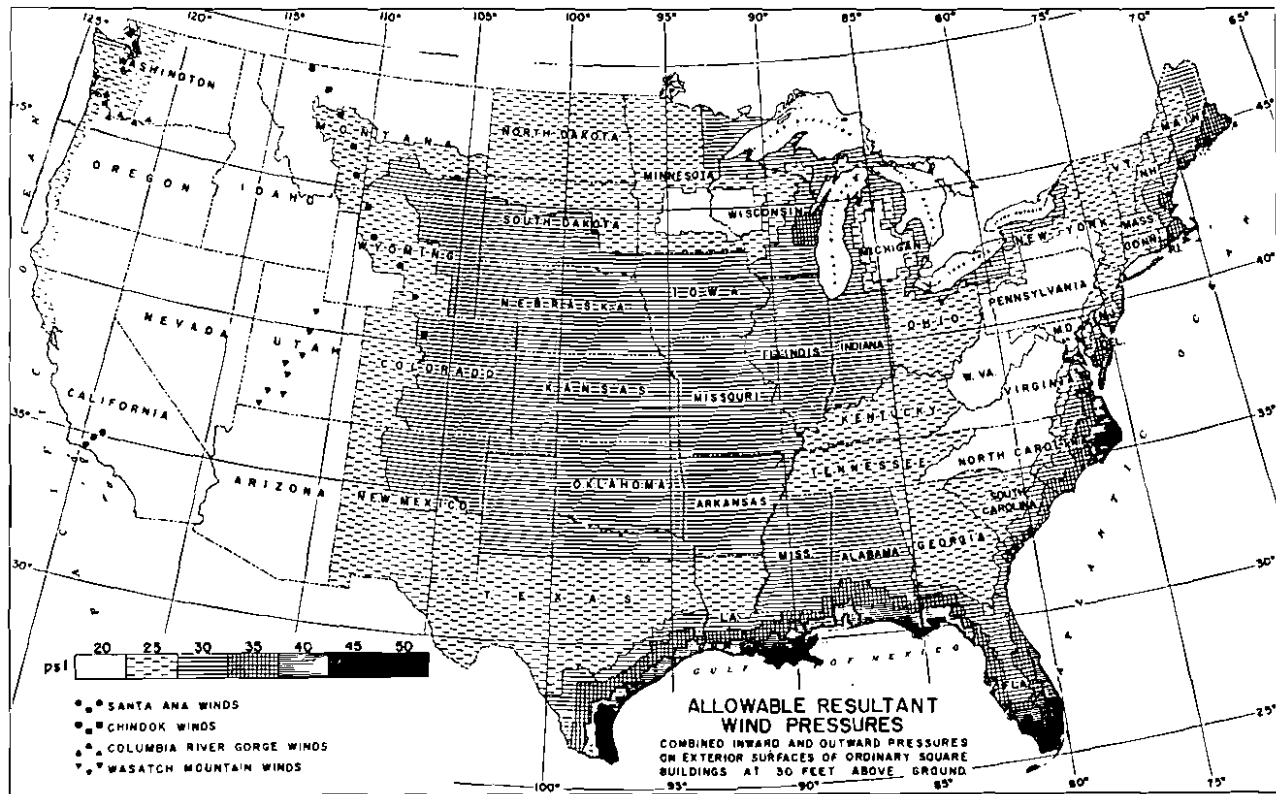


FIGURE NO. 1

(f) **Solid Towers.** Chimneys, tanks, and solid towers shall be designed and constructed to withstand the pressures as specified by this Section, multiplied by the factors set forth in Table No. 23-F.

(g) **Open Frame Towers.** Radio towers and other towers of trussed construction shall be designed and constructed to withstand wind pressures specified in this Section, multiplied by the shape factors set forth in Table No. 23-G.

Wind pressures shall be applied to the total normal projected area of all the elements of one face (excluding ladders, conduits, lights, elevators, etc., which shall be accounted for separately by using the indicated factor for these individual members).

(h) **Miscellaneous Structures.** Greenhouses, lath houses, agricultural buildings and patio structures shall be designed for the horizontal wind pressures as set forth in Table No. 23-E, except that, if the height zone is ten feet (10') or less, two-thirds of the first line of listed values may be used. The structures shall be designed to withstand an uplift wind pressure equal to three-fourths of the horizontal pressure.

(i) **Moment of Stability.** The overturning moment calculated from the wind pressure shall in no case exceed two-thirds of the dead load resisting moment.

The weight of earth superimposed over footings may be used to calculate the dead load resisting moment.

(j) **Combined Wind and Live Loads.** For the purpose of determining stresses all vertical design loads except the roof

**Wind Pressure
(Continued)**

TABLE NO. 23-G—SHAPE FACTORS FOR RADIO TOWERS AND TRUSSED TOWERS

TYPE OF EXPOSURE	FACTOR
Wind normal to one face of tower	
Four-cornered, flat or angular sections, steel or wood	2.20
Three-cornered, flat or angular sections, steel or wood	2.00
Wind on corner, four-cornered tower, flat or angular sections	2.40
Wind parallel to one face of three-cornered tower, flat or angular sections	1.50
Factors for towers with cylindrical elements are approximately two-thirds of those for similar towers with flat or angular sections	
Wind on individual members	
Cylindrical members	
Two inches or less in diameter	1.00
Over two inches in diameter	0.80
Flat or angular sections	1.30

live load and crane loads shall be considered as acting simultaneously with the wind pressure.

**Live Loads
Posted**

Sec. 2309. The live loads for which each floor or part thereof of a commercial or industrial building is or has been designed shall have such designed live loads conspicuously posted by the owner in that part of each story in which they apply, using durable metal signs, and it shall be unlawful to remove or deface such notices. The occupant of the building shall be responsible for keeping the actual load below the allowable limits.

**Retaining
Walls**

Sec. 2310. Retaining walls shall be designed to resist the lateral pressure of the retained material in accordance with accepted engineering practice. Walls retaining drained earth may be designed for pressure equivalent to that exerted by a fluid weighing not less than 30 pounds per cubic foot and having a depth equal to that of the retained earth. Any surcharge shall be in addition to the equivalent fluid pressure.

**Footing
Design**

Sec. 2311. See Section 2806.

**Walls and
Structural
Framing**

Sec. 2312. (a) General. Walls and structural framing shall be erected true and plumb in accordance with the design. Bracing shall be placed during erection wherever necessary to take care of all loads to which the structure may be subjected.

(b) Interior Walls. Interior walls, permanent partitions, and temporary partitions which exceed three-fourths of the height of the room in which they are placed shall be designed to resist all loads to which they are subjected but not less than a force of 10 pounds per square foot applied perpendicular to the walls. The deflection of such walls under a load of five pounds per square foot shall not exceed $1/240$ of the span for walls with brittle finishes and $1/120$ of the span for walls with flexible finishes. See Table No. 23-I for earthquake design requirements where such requirements are more restrictive.

Anchorage

Sec. 2313. Concrete or masonry walls shall be anchored to all floors and roofs which provide lateral support for the wall or are required to provide stability for the wall. Such anchorage shall be capable of resisting the horizontal forces specified in this Chapter or a minimum force of 200 pounds per linear foot of wall, whichever is the larger.

**Earthquake
Regulations**

Sec. 2314. (a) General. Every building or structure and every portion thereof shall be designed and constructed to resist stresses produced by lateral forces as provided in this Section. Stresses shall be calculated as the effect of a force applied horizontally at each floor or roof level above the foundation. The force shall be assumed to come from any horizontal direction.

(b) **Definitions.** The following definitions apply only to the provisions of this Section.

**Earthquake
Regulations
(Continued)**

SPACE FRAME is a three-dimensional structural system composed of interconnected members, other than shear or bearing walls, laterally supported so as to function as a complete self-contained unit with or without the aid of horizontal diaphragms or floor bracing systems.

SPACE FRAME—VERTICAL LOAD-CARRYING is a space frame designed to carry all vertical loads.

SPACE FRAME—MOMENT RESISTING is a vertical load-carrying space frame in which the members and joints are capable of resisting design lateral forces by bending moments. This system may or may not be enclosed by or adjoined by more rigid elements which would tend to prevent the space frame from resisting lateral forces.

BOX SYSTEM is a structural system without a complete vertical load-carrying space frame. In this system the required lateral forces are resisted by shear walls as hereinafter defined.

SHEAR WALL is a wall designed to resist lateral forces parallel to the wall. Braced frames subjected primarily to axial stresses shall be considered as shear walls for the purpose of this definition.

(c) **Symbols and Notations.** The following symbols and notations apply only to the provisions of this Section.

- C = Numerical coefficient for base shear as specified in Section 2314 (d) 1.
- C_p = Numerical coefficient as specified in Section 2314 (d) 2 and as set forth in Table No. 23-I.
- D = The dimension of the building in feet in a direction parallel to the applied forces.
- F_a = Allowable axial stress.
- f_a = Computed axial stress.
- F_b = Allowable bending stress.
- f_b = Computed bending stress.
- F_p = Lateral forces on the part of the structure and in the direction under consideration.
- F_x = Lateral forces applied to a level designated as "x."
- H = The height of the main portion of the building in feet above the base.
- h_x = Height in feet above the base to the level designated as "x."
- J = Numerical coefficient for base moment as specified in Section 2314 (h).

**Earthquake
Regulations
(Continued)**

- K = Numerical coefficient as set forth in Table No. 23-H.
 Σwh = Summation of the products of all " w_i " " h_i " for the building.
 M = Overturning moment at the base of the building or structure.
 N = Total number of stories above exterior grade.
 T = Fundamental period of vibration of the building or structure in seconds in the direction under consideration.
 V = Total lateral load or shear at the base.
 W = Total dead load.

EXCEPTION: " W " shall be equal to the total dead load plus 25 per cent of the floor live load in storage and warehouse occupancies.

- W_p = The weight of a part or portion of a structure.
 w_x = That portion of " w " which is located at or is assigned to the level designated as " x ."
 Z = Numerical coefficient dependent upon the zone as determined by the map on the inside back cover. For locations in Zone No. 1 " Z " shall be equal to one-fourth. For locations in Zone No. 2 " Z " shall be equal to one-half. For locations in Zone No. 3 " Z " shall be equal to one.

(d) **Minimum Earthquake Forces for Buildings.** 1. **Total lateral force and distribution of lateral force.** Every building shall be designed and constructed to withstand minimum total lateral seismic forces assumed to act noneconcentrantly in the direction of each of the main axes of the building in accordance with the following formula:

$$V = ZKCW$$

The value of " K " shall be not less than that set forth in Table No. 23-H. The value of " C " shall be determined in accordance with the following formula:

$$C = \frac{0.05}{\sqrt[3]{T}}$$

EXCEPTIONS: 1. " C " = 0.10 for all one-story and two-story buildings.

2. The product " KC " shall be not less than 0.12 or more than 0.25 for elevated tanks on four or more cross-braced legs.

" T " is the fundamental period of vibration of the structure in seconds in the direction considered. Properly substantiated technical data for establishing the period " T " for the contemplated structure may be submitted. In the absence of such

data, the value of "T" shall be determined by the following formula:

**Earthquake
Regulations
(Continued)**

$$T = \frac{0.05 H}{\sqrt{D}}$$

EXCEPTIONS: 1. "T" = 0.10 N in all buildings in which the lateral resisting system consists of a moment-resisting space frame which resists 100 per cent of the required lateral forces and which frame is not enclosed by or adjoined by more rigid elements which would tend to prevent the frame from resisting lateral forces. For the purpose of computing "C" the value of "T" need not be less than 0.10 seconds.

2. The period "T" for elevated tanks or towers with four or more legs, cross braced, shall be computed by an acceptable method.

The total lateral force "V" shall be distributed over the height of the building in accordance with the following formula:

$$F_x = \frac{V w_x h_x}{\sum w h}$$

EXCEPTIONS: 1. One-story and two-story buildings shall have uniform distribution.

2. Where the height to depth ratio of a lateral force resisting system is equal to or greater than five to one, 10 per cent of the total force "V" shall be considered as concentrated at the top story. The remaining 90 per cent shall be distributed as provided for in the above formula.

At each level designated as "x," the force "F_x" shall be applied over the area of the building in accordance with the mass distribution on that level.

2. **Lateral force on parts or portions of buildings or other structures.** Parts or portions of buildings or structures and their anchorage shall be designed for lateral forces in accordance with the following formula:

$$F_p = Z C_p W_p$$

The values of "C_p" are set forth in Table No. 23-I. The distribution of these forces shall be according to the gravity loads pertaining thereto.

3. **Pile foundations.** Individual pile or caisson footings of every building or structure shall be so interconnected by ties each of which can carry by tension and compression a horizontal force equal to 10 per cent of the larger pile cap loading unless it can be demonstrated that equivalent restraint can be provided by other approved methods.

**Earthquake
Regulations
(Continued)**

(e) **Distribution of Horizontal Shear.** Total shear in any horizontal plane shall be distributed to the various resisting elements in proportion to their rigidities considering the rigidity of the horizontal bracing system or diaphragm as well as the rigidities of the vertical resisting elements.

(f) **Drift.** Lateral deflections or drift of a story relative to its adjacent stories shall be considered in accordance with accepted engineering practice.

(g) **Horizontal Torsional Moments.** Provisions shall be made for the increase in shear resulting from the horizontal torsion due to an eccentricity between the center of mass and the center of rigidity. Negative torsional shears shall be neglected. In addition, where the vertical resisting elements depend on diaphragm action for shear distribution at any level, the shear resisting elements shall be capable of resisting

**TABLE NO. 23-H—HORIZONTAL FORCE FACTOR "K" FOR BUILDINGS
OR OTHER STRUCTURES¹**

TYPE OR ARRANGEMENT OF RESISTING ELEMENTS	VALUE ² OF K
All building framing systems except as hereinafter classified	1.00
Buildings with a box system as specified in Section 2314 (b)	1.33
Buildings with a complete horizontal bracing system capable of resisting all lateral forces, which system includes a moment resisting space frame, which when assumed to act independently is capable of resisting a minimum of 25 per cent of the total required lateral force.	0.80
Buildings with a moment resisting space frame which when assumed to act independently of any other more rigid elements is capable of resisting 100 per cent of the total required lateral forces in the frame alone.	0.67
Elevated tanks supported with four or more cross-braced columns and not supported by a building	3.00 ³
Structures other than buildings and other than those set forth in Table No. 23-I.	1.50

¹Where wind load as set forth in Section 2307 would produce higher stresses, this load shall be used in lieu of the loads resulting from earthquake forces.

²See map on inside back cover for seismic probability zones and definition of "Z" as set forth in Subsection (c).

³The tower shall be designed for no accidental torsion of five per cent as set forth in Section 2314 (g). Elevated tanks which are supported by buildings or do not conform to type or arrangement of supporting elements as described above shall be designed in accordance with Section 2314 (d) 2 using " C_p " = .2.

a torsional moment assumed to be equivalent to the story shear acting with an eccentricity of not less than five per cent of the maximum building dimension at that level.

(h) **Overtuning.** Every building or structure shall be designed to resist the overturning effects caused by the wind forces and related requirements specified in Section 2307, or the earthquake forces specified in this Section, whichever governs.

**Earthquake
Regulations
(Continued)**

EXCEPTION: The axial loads from earthquake force on vertical elements and footings in every building or structure may be modified in accordance with the following provisions:

1. The overturning moment "M" at the base of the building or structure shall be determined in accordance with the following formula:

$$M = J \sum F_x h_x$$

WHERE:

$$J = \frac{0.5}{\sqrt{T^3}}$$

The required value of "J" shall be not less than 0.33 nor more than 1.00.

"J" shall be 1 for elevated tanks supported with four or more cross-braced legs.

2. The overturning moment "M_x" at any level designated as "x" shall be determined in accordance with the following formula:

$$M_x = \frac{H - h_x}{H} M$$

At any level the overturning moments shall be distributed to the various resisting elements in the same proportion as the distribution of the shears in the resisting system. Where other vertical members are provided which are capable of partially resisting the overturning moments, a redistribution may be made to these members if framing members of sufficient strength and stiffness to transmit the required loads are provided.

Where a vertical resisting element is discontinuous, the overturning moment carried by the lowest story of that element shall be carried down as loads to the foundation.

(i) **Set-Backs.** Buildings having set-backs wherein the plan dimension of the tower in each direction is at least 75 per cent of the corresponding plan dimension of the lower part may be considered as a uniform building without set-backs for the purpose of determining seismic forces.

For other conditions of set-backs the tower shall be designed as a separate building using the larger of the seismic

**Earthquake
Regulations
(Continued)**

coefficients at the base of the tower determined by considering the tower as either a separate building for its own height or as part of the over-all structure. The resulting total shear from the tower shall be applied at the top of the lower part of the building which shall be otherwise considered separately for its own height.

(j) **Structural Frame.** Buildings more than 13 stories or one hundred and sixty feet (160') in height shall have a complete moment resisting space frame capable of resisting not less than 25 per cent of the required seismic load for the structure as a whole. The frame shall be made of a ductile material or a ductile combination of materials. The necessary ductility shall be considered to be provided by a steel frame with moment resistant connections or by other systems proved by tests and studies to provide equivalent energy absorption.

TABLE NO. 23-1—HORIZONTAL FORCE FACTOR " C_p " FOR PARTS OR PORTIONS OF BUILDINGS OR OTHER STRUCTURES

PART OR PORTION OF BUILDINGS	DIRECTION OF FORCE	VALUE OF C_p
Exterior bearing and nonbearing walls, interior bearing and nonbearing walls which extend three-fourths of the height of the room, and masonry and concrete fences over six feet (6') in height. ¹	Normal to flat surface	0.2
Cantilever parapet and other cantilever walls, except retaining walls.	Normal to flat surface	1.00
Exterior and interior ornamentations and appendages.	Any direction	1.00
When connected to or a part of a building: towers, tanks, towers and tanks plus contents, chimneys, smokestacks, and penthouses.	Any direction	0.20 ²
When resting on the ground, tank plus effective mass of its contents.	Any direction	0.10
Floors and roofs acting as diaphragms. ³	Any direction	0.10

¹In no case shall horizontal force be less than 10 pounds per square foot. See Section 2313 (b) for limitations on deflection.

²When " H/D " of any building is equal to or greater than five to one increase value by 50 per cent.

³Floors and roofs acting as diaphragms shall be designed for a minimum value of " C_p " of 10 per cent applied to loads tributary from that story unless a greater value of " C_p " is required by the basic seismic formula $V = ZKCW$.

(k) **Design Requirements.** 1. Combined axial and bending stresses in columns forming a part of a space frame. Maximum allowable extreme fiber stress in columns at intersection of columns with floor beams or girders for combined axial and bending stresses shall be the allowable bending stress for the material used. Within the center one-half of the unsupported length of the column, the combined axial and bending stresses shall be such that

$$\frac{f_a}{F_a} + \frac{f_b}{F_b}$$

is equal to or less than 1.

When stresses are due to a combination of vertical and lateral loads, the allowable unit stresses may be increased as specified in Section 2303.

2. **Building separations.** All portions of structures shall be designed and constructed to act as an integral unit in resisting horizontal forces unless separated structurally by a distance sufficient to avoid contact under deflection from seismic action or wind forces.

3. **Minor alterations.** Minor structural alterations may be made in existing buildings and other structures, but the resistance to lateral forces shall be not less than that before such alterations were made, unless the building as altered meets the requirements of this Section of the Code.

4. **Unreinforced masonry.** All elements within the structure which are of masonry or concrete and which resist seismic forces or movement shall be reinforced so as to qualify as reinforced masonry or concrete as specified in Chapters 24 and 26.

5. **Combined vertical and horizontal forces.** In computing the effect of seismic force in combination with vertical loads, gravity load stresses induced in members by dead load plus design live load, except roof live load, shall be considered.

CHAPTER 24—MASONRY

Scope

Sec. 2401. All masonry shall conform to the regulations of this Code.

Definitions

Sec. 2402. For the purpose of this Chapter certain terms are defined as follows:

DIMENSIONS. Dimensions given are nominal; actual dimensions of unit masonry may not be decreased by more than one-half inch ($\frac{1}{2}$ ").

GROSS CROSS-SECTIONAL AREA OF HOLLOW UNITS, the total area including cells of a section perpendicular to the direction of loading. Re-entrant spaces are included in the gross area, unless these spaces are to be occupied in masonry by portions of adjacent units.

MASONRY UNIT, any brick, tile, stone, or block conforming to the requirements specified in Section 2403.

Materials

Sec. 2403. (a) **General.** The quality, testing and design of masonry materials used structurally in buildings or structures shall conform to the requirements specified in this Chapter and to the following standards:

MATERIALS AND DESIGN		U.B.C. DESIGNATION
BUILDING BRICK		
Clay or Shale.....		24- 1-64
Sand-Lime		24- 2-64
Concrete		24- 3-64
CONCRETE MASONRY UNITS		
Hollow Load-Bearing.....		24- 4-64
Solid Load-Bearing.....		24- 5-64
Hollow Nonload-Bearing.....		24- 6-64
Method of Test.....		24- 7-64
STRUCTURAL CLAY TILE		
For Walls—Load-Bearing		24- 8-64
For Walls—Nonbearing		24- 9-64
For Floors		24-10-64
GYPSUM		
Partition Tile or Block.....		24-11-64
General		24-12-64
Reinforced and Precast.....		24-13-64
CAST STONE		24-14-64
REINFORCEMENT		
Reinforcing Steel.....		26- 6-64
Joint Reinforcement.....		24-15-64
CEMENT		
Portland Cement.....		26- 1-64
Air-Entraining Portland Cement.....		24-16-64
Masonry Cement.....		24-17-64

LIME**Materials
(Continued)**

Quicklime	24-18-64
Hydrated Lime for Masonry Purposes.....	24-19-64
Processed Pulverized Quicklime.....	24-20-64

MORTAR

Other than Gypsum.....	24-21-64
Aggregates for Mortar.....	24-22-64
Field Tests for Mortar.....	24-23-64

GROUT

Aggregates for Grout.....	24-24-64
Field Tests for Grout.....	24-23-64

TESTING

Brick	24-25-64
Gypsum	24-26-64

(b) **Brick Made from Clay or Shale.** Building brick of clay or shale shall be of a quality at least equal to the requirements set forth in U.B.C. Standard No. 24-1-64. When in contact with the ground, brick shall be of at least Grade MW. Where severe frost action occurs in the presence of moisture, brick shall be at least Grade SW.

(c) **Brick Made from Sand-Lime.** Building brick made from sand-lime shall be of a quality at least equal to the requirements set forth in U.B.C. Standard No. 24-2-64. When in contact with the ground, brick shall be of at least Grade MW. Where severe frost action occurs in the presence of moisture, brick shall be at least Grade SW.

(d) **Concrete Brick.** Building brick of concrete shall be of a quality at least equal to the requirements set forth in U.B.C. Standard No. 24-3-64.

(e) **Concrete Masonry Units.** Concrete masonry units shall be of a quality at least equal to the requirements set forth in U.B.C. Standard No. 24-4-64 or No. 24-5-64 when used for bearing walls or piers, or when in contact with ground or exposed to the weather; or equal to the requirements set forth in U.B.C. Standard No. 24-6-64 when used for nonbearing purposes and not exposed to the weather. Solid units subject to the action of weather or soil shall be Grade A. Concrete masonry units shall be tested as set forth in U.B.C. Standard No. 24-7-64.

(f) **Structural Clay Tile.** Structural clay tile shall be of a quality at least equal to the requirements set forth in U.B.C. Standard No. 24-8-64, Grade LB when used for bearing walls or piers, or Grade LBX when exposed to the weather or soil; or equal to the requirements set forth in U.B.C. Standard No. 24-9-64 when used for interior nonload-bearing purposes; or equal to the requirements set forth in U.B.C. Standard No. 24-10-64 when used for floor construction.

(g) **Gypsum Units and Gypsum.** Gypsum partition tile or block shall be of a quality at least equal to the requirements

Materials
(Continued)

set forth in U.B.C. Standard No. 24-11-64. Gypsum shall conform to U.B.C. Standard No. 24-12-64. Reinforced gypsum concrete shall conform to U.B.C. Standard No. 24-13-64.

(h) **Cast Building Stones.** Cast building stone shall be equal to the requirements set forth in U.B.C. Standard No. 24-14-64. Every concrete unit more than eighteen inches (18") in any dimension shall conform to the requirements for concrete in Chapter 26.

(i) **Unburned Clay Brick.** Unburned clay brick shall conform to the requirements specified in Section 2405.

(j) **Stone.** Natural stone shall be sound, clean, and in conformity with other provisions of this Chapter.

(k) **Structural Glass Block.** Structural glass block shall have unglazed surfaces to allow adhesion on all mortared faces.

(l) **Glazed Building Units.** Glazed brick shall conform to the structural requirements for building brick of clay or shale, and glazed structural tile shall conform to the structural requirements for structural clay tile.

(m) **Reinforcing Steel.** Reinforcing steel shall conform to the physical and chemical requirements for metal reinforcement in concrete, as specified in U.B.C. Standard No. 26-6-64.

(n) **Masonry Joint Reinforcement.** Wire reinforcement shall conform to U.B.C. Standard No. 24-15-64.

(o) **Water.** Water used in mortar, grout, or masonry work shall be clean and free from injurious amounts of oil, acid, alkali, organic matter, or other harmful substances.

(p) **Cement.** Cement for mortar shall be Type I, II, or III portland cement as set forth in U.B.C. Standard No. 26-1-64, or Type I-A, II-A, or III-A air-entraining portland cement as set forth in U.B.C. Standard No. 24-16-64, or Type II masonry cement as set forth in U.B.C. Standard No. 24-17-64.

EXCEPTION: Approved types of plasticizing agents may be added to portland cement Type I or II in the manufacturing process, but not in excess of 12 per cent of the total volume. Plastic or waterproofed cements so manufactured shall meet the requirements for portland cement as set forth in U.B.C. Standard No. 26-1-64 except in respect to the limitations on insoluble residue, air-entrainment, and additions subsequent to calcination.

(q) **Lime.** Quicklime shall conform to U.B.C. Standard No. 24-18-64. Hydrated lime shall conform to the requirements of U.B.C. Standard No. 24-19-64. Lime putty shall be made from quicklime or hydrated lime.

If made from other than processed pulverized quicklime, the lime shall be slaked and then screened through a No. 16

mesh sieve. After slaking, screening, and before using, it shall be stored and protected for not less than 10 days. The resulting lime putty shall weigh not less than 83 pounds per cubic foot.

Processed pulverized quicklime conforming to U.B.C. Standard No. 24-20-64 shall be slaked for not less than 48 hours and shall be cool when used.

(r) **Mortar.** 1. **General.** Mortar other than gypsum mortar used in masonry construction shall be classified in accordance with (a) the materials and proportions set forth in Table No. 24-A, or (b) the properties as established by laboratory tests as set forth in U.B.C. Standard No. 24-21-64. Tests made to classify mortar by compressive strength shall be as set forth in U.B.C. Standard No. 24-21-64, using the proportions and materials proposed for use. Aggregates for mortar shall conform to the provisions set forth in U.B.C. Standard No. 24-22-64.

2. **Strength.** The strength of mortar using cementitious materials set forth in Table No. 24-A shall meet the minimum compressive strength shown. The Building Official may require field tests to verify compliance with this Section. Such tests shall be made in accordance with U.B.C. Standard No. 24-23-64.

(s) **Grout.** 1. **General.** Grout shall be proportioned by volume and shall have sufficient water added to produce consistency for pouring without segregation. Aggregate shall conform to the requirements set forth in U.B.C. Standard No. 24-24-64.

2. **Type.** Fine grout shall be composed of one part portland cement, to which may be added not more than one-tenth

Materials (Continued)

TABLE NO. 24-A—MORTAR PROPORTIONS
(Parts by Volume)

MORTAR TYPE	MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS (p.s.i.)	PORTLAND CEMENT	HYDRATED LIMES OR LIME PUTTY ¹		MASONRY CEMENTS TYPE II	DAMP LOOSE AGGREGATE
			MIN.	MAX.		
S	2000	1	$\frac{1}{4}$	$\frac{1}{2}$	—	Not less than $2\frac{1}{4}$ and not more than 3 times the sum of the volumes of the cement and lime used.
N	750	1	$\frac{1}{2}$	$1\frac{1}{4}$	—	
N (Ma- sonry)	750	—	—	—	1	
O	350	1	$1\frac{1}{4}$	$2\frac{1}{2}$	—	

¹When plastic or waterproof cement is used as specified in Section 2403 (p), hydrated lime or putty may be added but not in excess of one-tenth the volume of cement.

Materials
(Continued)

part hydrated lime or lime putty, and two and one-fourth to three parts sand.

Coarse grout shall be composed of one part portland cement to which may be added not more than one-tenth part hydrated lime or lime putty, and two to three parts sand, and not more than two parts gravel.

EXCEPTION: Mortar may be used for grout in chimney and fireplace construction as set forth in Section 3711 (f).

Coarse grout may be used in grout spaces in brick masonry two inches (2") or more in horizontal dimension and in grout spaces in filled-cell construction four inches (4") or more in both horizontal dimensions.

3. **Strength.** Grout shall attain a minimum compressive strength of 2000 pounds per square inch at 28 days. The Building Official may require a compressive field strength test of grout made in accordance with U.B.C. Standard No. 24-23-64.

(t) **Mortar Limitations.** Masonry units used in foundation walls and footings shall be laid up in Type S mortar. Type O mortar shall be used only in interior nonstructural walls. See Section 2415 (a). See Sections 2413 (b), 2415 (a), and 2417 (k).

(u) **Aggregates.** Aggregates for mortar shall be of a quality at least equal to that set forth in U.B.C. Standard No. 24-22-64.

(v) **Rate of Absorption.** At the time of laying, burned clay units and sand-lime units shall have a rate of absorption not exceeding 0.025 ounces per square inch during a period of one minute. In the absorption test the surface of the unit shall be held one-eighth inch ($\frac{1}{8}$ ") below the surface of the water.

(w) **Masonry Unit Surfaces.** Every masonry unit shall have all surfaces, to which mortar or grout is to be applied, capable of developing the masonry strengths required in this Chapter.

(x) **Re-use of Masonry Units.** Masonry units may be re-used when clean, whole, and conforming to the other requirements of this Section, except that the allowable working stresses shall be 50 per cent of that permitted for new masonry units.

Tests

Sec. 2404. (a) General. Tests of materials shall be made in accordance with the standard method prescribed for the material in question.

(b) **Load Tests.** When a load test is required, the member or portion of the structure under consideration shall be subject to a superimposed load equal to twice the design live load plus one-half of the dead load. This load shall be left in

position for a period of 24 hours before removal. If, during the test or upon removal of the load, the member or portion of the structure shows evidence of failure, such changes or modifications as are necessary to make the structure adequate for the rated capacity shall be made; or where lawful, a lower rating shall be established. A flexural member shall be considered to have passed the test if the maximum deflection "D" at the end of the 24-hour period neither exceeds

$$D = \frac{L}{200} \text{ nor } D = \frac{L^2}{4000t}$$

and the beams and slabs show a recovery of at least 75 per cent of the observed deflection within 24 hours after removal of the load.

WHERE:

L = span of the member in feet

t = thickness or depth of the member in feet.

(c) **Determination of Masonry Design Strength.** 1. **General.** The value of " f_m " may be determined by preliminary test of masonry assemblages.

2. **Preliminary Tests.** A. **General.** When the strength " f_m " is to be established by preliminary tests, they shall be made in advance of the beginning of operations using prisms built of the same materials, under the same conditions, and, insofar as possible, with the same bonding arrangements as for the structure. The moisture content of the units at time of laying, consistency of mortar, and workmanship shall be the same as will be used in the structure.

The compressive strength " f_m " shall be computed by dividing the ultimate load by the net area of the masonry used in the construction of the prisms. The gross area may be used in the determination of " f_m " for solid masonry units as defined in U.B.C. Standard No. 24-1-64.

B. **Prisms.** For walls, prisms shall be sixteen inches (16") high and sixteen inches (16") long. The thickness and type of construction of the specimen shall be similar to the wall under consideration.

For columns, prisms shall be sixteen inches (16") high and not less than eight inches by eight inches (8" x 8") in plan. Cores in hollow masonry shall not be filled, except for solid filled construction.

The symbol " f_m " shall be taken as the compressive strength of the specimens multiplied by the following correction factor:

Ratio of " h/d "	1.5	2.0	2.5	3.0
Correction factor	.86	1.00	1.11	1.20

WHERE:

h = height of specimen in inches

d = minimum dimension of specimen in inches

Tests
(Continued)

Tests**(Continued)**

C. **Storage of Test Prisms.** Test prisms shall be stored for seven days in air, at a temperature of 70 degrees, plus or minus 5°F., in a relative humidity exceeding 90 per cent, and then in air at a temperature of 70 degrees, plus or minus five degrees, at a relative humidity of 30 per cent to 50 per cent until tested. Prisms shall be capped and tested in compression similar to tests for molded concrete cylinders as specified in U.B.C. Standard No. 26-10-64.

D. **Sampling.** Not less than five specimens shall be made for each initial preliminary test to establish " f'_m ." Not less than three shall be made for each field test to confirm that the materials are as assumed in the design. The standard age of test specimens shall be 28 days, but seven-day tests may be used, provided the relation between the seven-day and 28-day strengths of the masonry is established by adequate test data for the materials used.

**Unburned
Clay
Masonry**

Sec. 2405. (a) **General.** Masonry of unburned clay units shall not be used in any building more than one story in height. The unsupported height of every wall of unburned clay units shall be not more than 10 times the thickness of such walls. Bearing walls shall in no case be less than sixteen inches (16"). Fireplaces and chimneys of unburned clay units shall be lined with firebrick not less in thickness than four inches (4"). All footing walls which support masonry of unburned clay units shall extend to an elevation not less than six inches (6") above the adjacent ground at all points.

(b) **Units.** At the time of laying, all units shall be clean and damp at the surface.

(c) **Laying.** All joints shall be solidly filled with mortar. Bond shall be provided as specified for masonry of hollow units in Section 2411.

(d) **Stresses.** All masonry of unburned clay units shall be so constructed that the unit stresses do not exceed those set forth in Table No. 24-B. Bolt values shall not exceed those set forth in Table No. 24-C.

(e) **Soil.** The soil used shall contain not less than 25 per cent and not more than 45 per cent of material passing a No. 200 mesh sieve. The soil shall contain sufficient clay to bind the particles together but shall not contain more than 0.2 per cent of water-soluble salts.

(f) **Stabilizer.** The stabilizing agent shall be emulsified asphalt. The stabilizing agent shall be uniformly mixed with the soil in amounts sufficient to provide the required resistance to absorption.

(g) **Sampling.** Each of the tests prescribed in this Section shall be applied to five sample units selected at random from each 5000 bricks to be used.

(h) **Compressive Strength.** The units shall have an average compressive strength of 300 pounds per square inch when tested in accordance with U.B.C. Standard No. 24-25-64. One sample out of five may have a compressive strength of not less than 250 pounds per square inch.

Unburned
Clay Masonry
(Continued)

**TABLE NO. 24-B—ALLOWABLE WORKING STRESSES IN
UNREINFORCED UNIT MASONRY**

MATERIAL	TYPE S MORTAR					TYPE N, AND N (MASONRY)		
	Com- pres- sion ¹	Shear or Tension In Flexure ^{2,3}		Tension In Flexure ⁴		Com- pres- sion ¹	Shear or Tension In Flexure ^{2,3}	
Special Inspection Required	No	Yes	No	Yes	No	No	Yes	No
Solid Brick Masonry								
4500 plus p.s.i.....	250	20	10	40	20	200	15	7.5
2500 to 4500 p.s.i..	175	20	10	40	20	140	15	7.5
1500 to 2500 p.s.i..	125	20	10	40	20	100	15	7.5
Solid Concrete Unit Masonry								
Grade A.....	175	12	6	24	12	140	12	6
Grade B.....	125	12	6	24	12	100	12	6
Grouted Masonry								
4500 plus p.s.i.....	350	25	12.5	50	25			
2500 to 4500 p.s.i..	275	25	12.5	50	25			
1500 to 2500 p.s.i..	225	25	12.5	50	25			
Hollow Unit Masonry	85	12 ⁵	6 ⁵	24 ⁵	12 ⁵	70	10 ⁵	5 ⁵
Cavity Wall Masonry Solid Units ⁵								
Grade A or 2500 p.s.i. plus.....	140	12	6	30	15	110	10	5
Grade B or 1500 to 2500 p.s.i.....	100	12	6	30	15	80	10	5
Hollow Units ⁵	70	12	6	30	15	50	10	5
Stone Masonry								
Cast Stone.....	400	8	4	—	—	320	8	4
Natural Stone.....	140	8	4	—	—	100	8	4
Gypsum Masonry.....	20	—	—	—	—	20		
Unburned Clay Masonry	30	8	4	—	—			

¹Allowable working stresses pounds per square inch gross cross-sectional area (except as noted). The allowable working stresses in bearing directly on concentrated loads may be 50 per cent greater than these values.

²This value of tension is based on tension across a bed joint, i.e., vertically in the normal masonry work.

³No tension allowed in stack bond across head joints.

⁴The values shown here are for tension in masonry in the direction of running bond, i.e., horizontally between supports.

⁵Net area in contact with mortar or net cross-sectional area.

**Unburned
Clay
Masonry
(Continued)**

**TABLE NO. 24-C—ALLOWABLE SHEAR ON BOLTS
Masonry of Unburned Clay Units**

DIAMETER OF BOLTS (Inches)	EMBEDMENTS (Inches)	SHEAR (Pounds)
½	—	—
¾	12	200
¾	15	300
¾	18	400
1	21	500
1 ¼	24	600

(i) **Modulus of Rupture.** The unit shall average 50 pounds per square inch in modulus of rupture when tested according to the following procedure:

1. A cured unit shall be laid over cylindrical supports two inches (2") in diameter, located two inches (2") from each end, and extending across the full width of the unit.

2. A cylinder two inches (2") in diameter shall be laid midway between and parallel to the supports.

3. Load shall be applied to the cylinder at the rate of 500 pounds per minute until rupture occurs.

4. The modulus of rupture is equal to $\frac{3 WL}{2 Bd^2}$

WHERE:

W = Load of rupture

L = Distance between supports

B = Width of brick

d = Thickness of brick

(j) **Moisture Content.** The moisture content of the unit shall be not more than four per cent by weight.

(k) **Absorption.** A dried four-inch (4") cube cut from a sample unit shall absorb not more than two and one-half per cent moisture by weight when placed upon a constantly water-saturated porous surface for seven days.

(l) **Shrinkage Cracks.** No units shall contain more than three shrinkage cracks, and no shrinkage crack shall exceed three inches (3") in length or one-eighth inch ($\frac{1}{8}$ ") in width.

(m) **Mortar.** All mortar used in masonry of unburned clay units shall be Type S mortar.

**Gypsum
Masonry**

Sec. 2406. (a) **General.** Gypsum masonry is that form of construction made with gypsum block or tile in which the units are laid and set in gypsum mortar. Gypsum masonry

shall not be used in any bearing wall or where exposed directly to the weather or where subject to frequent or continuous wetting.

(b) **Materials.** Gypsum masonry shall be gypsum block or tile laid up in gypsum mortar composed of one part gypsum and not more than three parts sand by weight.

(c) **Stresses.** All gypsum masonry shall be so constructed that the unit stresses do not exceed those set forth in Table No. 24-B when computed on the gross cross-sectional area.

(d) **Bond.** The bond in gypsum masonry shall conform to the requirements for bond in masonry of hollow units specified in Section 2411.

(e) **Method of Laying.** All units in gypsum masonry shall be placed in side construction with cells horizontal. The entire bearing surface of every unit shall be covered with mortar spread in an even layer, and all joints shall be filled with mortar.

Sec. 2407. (a) General. Reinforced gypsum concrete shall consist of a mixture of gypsum with wood chips, shavings, or fiber or other approved aggregates, premixed at the mill with only water added at the job. Precast reinforced gypsum shall conform to U.B.C. Standard No. 24-13-64 and shall contain not more than three per cent. and cast-in-place reinforced gypsum concrete not more than 12½ per cent of wood chips, shavings, or fiber measured as a percentage by weight of dry mix.

Reinforced gypsum concrete shall develop the minimum ultimate compressive strength in pounds per square inch set forth in Table No. 24-D when dried to constant weight, with tests made on cylinders two inches (2") in diameter and four inches (4") long or on two-inch (2") cubes.

Tests when required shall follow the procedure set forth in U.B.C. Standard No. 24-26-64.

For special inspection, see Section 305 (a).

(b) **Design.** For precast slabs which cannot be analyzed in accordance with established principles of mechanics, the safe load, uniformly distributed, shall be taken as one-fifth of the total load causing failure in a full-size test panel with the

**Gypsum
Masonry
(Continued)**

**Reinforced
Gypsum
Concrete**

**TABLE NO. 24-D—MINIMUM ULTIMATE COMPRESSIVE STRENGTH
REINFORCED GYPSUM CONCRETE**

CLASS	MIXTURE	COMPRESSIVE STRENGTH (Pounds per Square Inch)
A	Not more than 12½ per cent by weight of wood chips, shavings, or fiber.	500
B	Not more than three per cent by weight of wood chips, shavings, or fiber.	1000

**Reinforced
Gypsum
Concrete
(Continued)**

load applied along two lines each distant one-fourth of the clear span from the support.

The minimum thickness of reinforced gypsum concrete shall be two inches (2") except in the suspension system, which shall be not less than three inches (3"). Hollow precast reinforced gypsum concrete units for roof construction shall be not less than three inches (3") thick and the shell not less than one-half inch ($\frac{1}{2}$ ") thick.

Precast gypsum concrete units shall be reinforced and, unless the shape or marking of the unit is such as to insure its being placed right side up, the reinforcement shall be placed symmetrically so that the unit can support its load either side up.

In slabs of the suspension type, the reinforcement shall consist of wires with continuity through multiple spans and anchored at the ends. The wires shall be supported in the top of the slab by the roof or floor beams and shall be tightly drawn down as near to the bottom of the slab at mid-span as fire protection requirements will allow, but not closer than one-half inch ($\frac{1}{2}$ "). Provisions shall be made in the framing of the end bays of this system for resisting the forces due to end anchorage of the wires. The wires shall be designed for a tension in pounds per foot width of slab equal to

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

WHERE:

w = The total load in pounds per square foot

L = The clear span in feet

d = The sag of the wires in feet

(c) **Stresses.** The maximum allowable unit working stresses in reinforced gypsum concrete shall not exceed the values set forth in Table No. 24-E except as specified in Chapter 23. Bolt values shall not exceed those set forth in Table No. 24-F.

**Glass
Masonry**

Sec. 2408. (a) **General.** Masonry of glass blocks may be used in nonload-bearing exterior or interior walls and in openings which might otherwise be filled with windows, either isolated or in continuous bands, provided the glass block panels have a minimum thickness of three and one-half inches ($3\frac{1}{2}$ ") at the mortar joint and the mortared surfaces of the blocks are treated for mortar bonding.

(b) **Horizontal Forces.** The panels shall be restrained laterally to resist the horizontal forces specified in Chapter 23 for bearing walls.

(c) **Size of Panels.** Glass block panels for exterior walls shall not exceed one hundred and forty-four square feet (144 sq. ft.) of unsupported wall surface nor fifteen feet (15') in any dimension. For interior walls, glass block panels shall not

**TABLE NO. 24-E—ALLOWABLE UNIT WORKING STRESS
REINFORCED GYPSUM CONCRETE****Glass Masonry
(Continued)**

TYPE OF STRESS	CLASS A	CLASS B
	(Pounds per Square Inch)	
Compression—Flexural	125	220
Compression—Bearing	100	165
Bond and Shear	10	20
Modulus of Elasticity	200,000	600,000

Note: Reinforced anchored or electrically welded wire mesh reinforcement shall be considered as meeting the bond and shear requirements of this Section.

**TABLE NO. 24-F—SHEAR ON ANCHOR BOLTS AND DOWELS
REINFORCED GYPSUM CONCRETE**

BOLT OR DOWEL SIZE (Inches)	EMBEDMENT (Inches)	SHEAR (Pounds)
¾ Bolt	4	250
½ Bolt	4	350
⅝ Bolt	4	500
¼ Plain dowel	6	200
¾ Deformed dowel	6	250
½ Deformed dowel	6	350

exceed two hundred and fifty square feet (250 sq. ft.) of unsupported area nor twenty-five feet (25') in any dimension.

(d) **Mortar.** Glass block shall be laid in Type S mortar. Both vertical and horizontal mortar joints shall be at least one-fourth inch ($\frac{1}{4}$ ") and not more than three-eighths inch ($\frac{3}{8}$ ") thick and shall be completely filled.

(e) **Expansion Joints.** Every exterior glass block panel shall be provided with one-half-inch ($\frac{1}{2}$ ") expansion joints at the sides and top. Expansion joints shall be entirely free of mortar, and shall be filled with resilient material.

Sec. 2409. (a) General. Stone masonry is that form of construction made with natural or cast stone in which the units are laid and set in mortar, with all joints thoroughly filled.

**Stone
Masonry**

(h) **Construction.** In ashlar masonry, bond stones uniformly distributed shall be provided to the extent of not less than 10 per cent of the area of exposed facets.

Rubble stone masonry twenty-four inches (24") or less in thickness shall have bond stones with a maximum spacing of three feet (3') vertically and three feet (3') horizontally, and if the masonry is of greater thickness than twenty-four inches (24"), shall have one bond stone for each six square feet (6 sq. ft.) of wall surface on both sides.

**Stone Masonry
(Continued)**

(c) **Minimum Thickness.** Stone masonry walls shall in no case have a minimum thickness of less than sixteen inches (16").

(d) **Stresses.** The allowable unit working stresses in stone masonry shall not exceed the values set forth in Table No. 24-B. Bolt values shall not exceed those set forth in Table No. 24-G.

**Cavity Wall
Masonry**

Sec. 2410. (a) General. Cavity wall masonry is that type of construction made with brick, structural clay tile, or concrete masonry units or any combination of such units in which facing and backing are completely separated except for the metal ties which serve as bonding.

(b) **Construction.** In cavity walls neither the facing nor the backing shall be less than three and one-half inches (3½") in net thickness and the cavity shall be not less than one-inch (1") net in width nor more than three inches (3") in width. The facing and backing of cavity walls shall be bonded with three-sixteenths-inch (⅜") diameter steel rods or metal ties of equivalent stiffness embedded in the horizontal joints. There shall be one metal tie for not more than each four and one-half square feet (4½ sq. ft.) of wall area. Ties in alternate courses shall be staggered and the maximum vertical distance between ties shall not exceed eighteen inches (18"), and the maximum horizontal distance shall not exceed thirty-six inches (36"). Rods bent to rectangular shape shall be used with hollow masonry units laid with the cells vertical; in other walls the ends of ties shall be bent to 90-degree angles to provide hooks not less than two inches (2") long. Additional bonding ties shall be provided at all openings, spaced not more than three feet (3') apart around the perimeter and within twelve inches (12") of the opening. Ties shall be of corrosion-resistant metal, or shall be coated with a corrosion-resistant metal or other approved protective coating.

(c) **Maximum Height.** The maximum height of cavity walls shall be as specified in Section 2418 (e).

**TABLE NO. 24-G—ALLOWABLE SHEAR ON BOLTS FOR ALL MASONRY
EXCEPT GYPSUM AND UNBURNED CLAY UNITS**

DIAMETER OF BOLT (Inches)	EMBEDMENT (Inches)	SOLID MASONRY (Shear in Pounds)	GROUTED MASONRY (Shear in Pounds)
½	4	350	550
⅝	4	500	750
¾	5	750	1100
⅞	6	1000	1500
1	7	1250	1850 ¹
1 ⅛	8	1500	2250 ¹

¹Permitted only with not less than 2500 pounds per square inch units.

(d) **Stresses.** The allowable unit working stresses in cavity wall construction shall not exceed the values set forth in Table No. 24-B. Bolt values shall not exceed those set forth in Table No. 24-G.

**Cavity Wall
Masonry
(Continued)**

Sec. 2411. (a) General. Hollow unit masonry is that type of construction made with hollow masonry units in which the units are all laid and set in mortar.

**Hollow
Unit Masonry**

All units shall be laid with full face shell mortar beds. All head and end joints shall be filled solidly with mortar for a distance in from the face of the unit or wall not less than the thickness of the longitudinal face shells.

(b) **Construction.** Where two or more hollow units are used to make up the thickness of a wall, the stretcher courses shall be bonded at vertical intervals not exceeding thirty-four inches (34") by lapping at least four inches (4") over the unit below or by lapping at vertical intervals not exceeding seventeen inches (17") with units which are at least 50 per cent greater in thickness than the units below; or by bonding with corrosion-resistant metal ties conforming to the requirements for cavity walls. There shall be one metal tie for not more than each four and one-half square feet (4½ sq. ft.) of wall area. Ties in alternate courses shall be staggered, and the maximum vertical distance between ties shall not exceed eighteen inches (18"), and the maximum horizontal distance shall not exceed thirty-six inches (36"). Walls bonded with metal ties shall conform to the requirements for allowable stress, lateral support, thickness (excluding cavity), height, and mortar for cavity walls.

(c) **Stresses.** All hollow unit masonry shall be so constructed that the unit stresses do not exceed those set forth in Table No. 24-B. Bolt values shall not exceed those set forth in Table No. 24-G.

Sec. 2412. (a) General. Solid masonry shall be brick, concrete brick, or solid load-bearing concrete masonry units, laid contiguously in mortar.

**Solid
Masonry**

All units shall be laid with full shoved mortar joints, and all head, bed, and wall joints shall be solidly filled with mortar.

(b) **Construction.** In each wythe of bearing and nonbearing walls, except masonry veneer, not less than 75 per cent of the units in any transverse vertical plane shall lap the ends of the units above and below a distance not less than one and one-half inches (1½") or one-half the height of the units, whichever is greater, or the masonry shall be reinforced longitudinally as required in Section 2417 (c) for masonry laid in stack bond. Adjacent wythes in bearing and nonbearing walls shall be bonded by either of the following methods:

**Solid
Masonry
(Continued)**

1. **Headers.** The facing and backing shall be bonded so that not less than four per cent of the exposed face area is composed of solid headers extending not less than four inches (4") into the backing. The distance between adjacent full-length headers shall not exceed twenty-four inches (24") vertically or horizontally. Where the backing consists of two or more wythes the headers shall extend not less than four inches (4") into the most distant wythe or the backing wythes shall be bonded together with separate headers whose area and spacing conform to the foregoing.

2. **Metal ties.** The facing and backing shall be bonded with corrosion-resistant unit metal ties or cross wires of masonry joint reinforcement conforming to the requirements of Section 2410 (b) for cavity walls. Unit ties shall be of sufficient length to engage all wythes, with ends embedded not less than one inch (1") in mortar, or shall consist of two lengths the inner embedded ends of which are hooked and lapped not less than two inches (2").

Where the space between metal tied wythes is solidly filled with mortar the allowable stresses and other provisions for masonry bonded walls shall apply. Where the space is not filled, metal tied walls shall conform to the allowable stress, lateral support, thickness (excluding cavity), height, and mortar requirements for cavity walls.

(c) **Moisture Content.** For moisture content, see Section 2403 (v).

(d) **Stresses.** All solid masonry shall be so constructed that the unit stresses do not exceed those set forth in Table No. 24-B. Bolt values shall not exceed those set forth in Table No. 24-G.

**Grouted
Masonry**

Sec. 2413. (a) General. Grouted masonry is that form of construction made with brick or solid concrete brick units in which interior joints of masonry are filled by pouring grout therein as the work progresses.

(b) **Materials.** At the time of laying, all masonry units shall be free of excessive dust and dirt. For moisture content, see Section 2403 (v). Only Type S mortar shall be used.

(c) **Low-lift Grouted Construction.** Requirements for construction shall be as follows:

1. All units in the two outer tiers shall be laid with full shoved head and bed mortar joints. Masonry headers shall not project into the grout space.

2. All longitudinal vertical joints shall be grouted and shall be not less than three-fourths inch ($\frac{3}{4}$ ") in thickness. In members of three or more tiers in thickness, interior bricks shall be embedded into the grout so that at least three-fourths inch ($\frac{3}{4}$ ") of grout surrounds the sides and ends of each unit. All grout shall be puddled with a grout stick immediately after pouring.

3. One exterior tier may be carried up sixteen inches (16") before grouting, but the other exterior tier shall be laid up and grouted in lifts not to exceed six times the width of the grout space with a maximum of eight inches (8").

4. If the work is stopped for one hour or longer, the horizontal construction joints shall be formed by stopping all tiers at the same elevation and with the grout one inch (1") below the top.

(d) **High-lift Grouted Construction.** 1. All units in the two tiers shall be laid with full head and bed mortar joints.

2. The two tiers shall be bonded together with wall ties. Ties shall be not less than No. 9 wire in the form of rectangles four inches (4") wide and two inches (2") in length less than the over-all wall thickness. Kinks, water drips or deformations shall not be permitted in the ties. One tier of the wall shall be built up not more than sixteen inches (16") ahead of the other tier. Ties shall be laid not to exceed twenty-four inches (24") on center horizontally and sixteen inches (16") on center vertically for running bond and not more than twenty-four inches (24") on center horizontally and twelve inches (12") on center vertically for stack bond.

3. Cleanouts shall be provided for each pour by leaving out every other unit in the bottom tier of the section being poured. During the work a high pressure jet stream of water shall be used to remove mortar fins and any other foreign matter from the grout space. The cleanout shall be sealed after inspection and before grouting.

4. The grout space (longitudinal vertical joint) shall be not less than three inches (3") in width and shall be poured solidly with grout. Masonry walls shall cure at least three days to gain strength before pouring grout.

5. Vertical grout barriers or dams shall be built of solid masonry across the grout space the entire height of the wall to control the flow of the grout horizontally. Grout barriers shall be not more than twenty-five feet (25') apart.

6. Grout shall be a plastic mix suitable for pumping without segregation of the constituents and shall be mixed thoroughly. Grout shall be placed by pumping or by an approved alternate method and shall be placed before any initial set occurs and in no case more than one and one-half hours after water has been added.

7. Grouting shall be done in a continuous pour, in lifts not exceeding four feet (4'). It shall be consolidated by puddling or mechanical vibrating during placing and reconsolidated after excess moisture has been absorbed but before plasticity is lost. The grouting of any section of a wall between control

**Grouted Masonry
(Continued)**

**Grouted Masonry
(Continued)**

barriers shall be completed in one day with no interruptions greater than one hour.

8. Special inspection during grouting shall be provided in accordance with Section 305; however, the work shall not qualify for the stresses entitled "Special Inspection" in Table No. 24-H unless fully inspected.

(e) **Stresses.** All grouted masonry shall be so constructed that the unit stresses do not exceed those set forth in Table No. 24-B. Bolt values shall not exceed those set forth in Table No. 24-G.

**Reinforced
Grouted
Masonry**

Sec. 2414. (a) General. Reinforced grouted masonry shall conform to all of the requirements for grouted masonry specified in Section 2413 and also the requirements of this Section.

(b) **Construction.** The thickness of grout or mortar between masonry units and reinforcement shall be not less than one-fourth inch ($\frac{1}{4}$ "), except that one-fourth-inch ($\frac{1}{4}$ ") bars may be laid in horizontal mortar joints at least one-half inch ($\frac{1}{2}$ ") thick and steel wire reinforcement may be laid in horizontal mortar joints at least twice the thickness of the wire diameter.

(c) **Stresses.** See Section 2417 (1).

**Reinforced
Hollow Unit
Masonry**

Sec. 2415. (a) General. Reinforced hollow unit masonry is that type of construction made with hollow masonry units in which certain cells are continuously filled with concrete or grout, and in which reinforcement is embedded. Only Type S mortar shall be used.

(b) **Construction.** Requirements for construction shall be as follows:

1. All reinforced hollow unit masonry shall be built to preserve the unobstructed vertical continuity of the cells to be filled. Walls and cross webs forming such cells to be filled shall be full-bedded in mortar to prevent leakage of grout. All head (or end) joints shall be solidly filled with mortar for a distance in from the face of the wall or unit not less than the thickness of the longitudinal face shells. Bond shall be provided by lapping units in successive vertical courses or by equivalent mechanical anchorage.

2. Vertical cells to be filled shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical cell measuring not less than two inches by three inches (2" x 3").

3. Cleanout openings shall be provided at the bottoms of all cells to be filled at each lift or pour of grout where such lift or pour of grout is in excess of four feet (4') in height. Any overhanging mortar or other obstruction or debris shall be removed from the insides of such cell walls. The cleanouts shall be sealed before grouting, after inspection.

4. Vertical reinforcement shall be held in position at top and bottom and at intervals not exceeding 192 diameters of the reinforcement.

5. All cells containing reinforcement shall be filled solidly with grout. Grout shall be poured in lifts of eight feet (8') maximum height. All grout shall be consolidated at time of pouring by puddling or vibrating and then reconsolidated by again puddling later, before plasticity is lost.

When total grout pour exceeds eight feet (8') in height the grout shall be placed in four-foot (4') lifts and special inspection during grouting shall be required. Minimum cell dimension shall be three inches (3"). Special inspection at time of grouting shall not be considered as special inspection under Table No. 24-H or No. 24-I.

6. When the grouting is stopped for one hour or longer, horizontal construction joints shall be formed by stopping the pour of grout one and one-half inches (1½") below the top of the uppermost unit.

(c) **Stresses.** See Section 2417 (1).

Sec. 2416. (a) Freezing. All masonry shall be protected against freezing for at least 48 hours after being laid. No masonry shall be built upon frozen material.

(b) **Corbeling.** Corbels may be built only into solid masonry walls twelve inches (12") or more in thickness. The projection for each course in such corbel shall not exceed one inch (1"), and the maximum projection shall not exceed one-third the total thickness of the wall when used to support structural members, and not more than six inches (6") when used to support a chimney built into the wall. The top course of all corbels shall be a header course.

(c) **Wood.** Masonry shall not be supported by wood members except as provided for in Section 2510.

(d) **Masonry Foundations.** In one-story buildings having wood frame exterior walls, foundations not over twenty-four inches (24") high may be constructed of masonry units without mortared head joints provided the masonry units permit horizontal flow of the grout to adjacent units.

Sec. 2417. (a) Combination of Units. In walls or other structural members composed of different kinds or grades of units, materials, or mortars, the maximum stress shall not exceed the allowable stress for the weakest of the combinations of units, materials, and mortars of which the member is composed. The thickness of any facing which is used to resist stress shall be not less than one and one-half inches (1½").

(b) **Thickness of Walls.** For thickness limitations of walls as specified in this Chapter, nominal thickness shall be used. Stresses shall be determined on the basis of the net thickness

**Reinforced
Hollow Unit
Masonry
(Continued)**

**General
Construction
Requirements**

**General
Design**

TABLE NO. 24-H—MAXIMUM WORKING STRESSES FOR REINFORCED SOLID AND HOLLOW UNIT MASONRY

TYPE OF STRESS	SOLID UNITS				HOLLOW UNITS ¹	
	3000 p.s.i. on Gross		2500 p.s.i. on Gross		Grade A Units	
	$f'_m = 1800$	$f'_m = 900$	$f'_m = 1500$	$f'_m = 750$	$f'_m = 1350$	$f'_m = 675$
SPECIAL INSPECTION REQUIRED	YES	NO*	YES	NO	YES	NO
Compression—Axial, Walls.....	See Section 2418		See Section 2418		See Section 2418	
Compression—Axial, Columns.....	See Section 2420		See Section 2420		See Section 2420	
Compression—Flexural	600	300	500	250	450	225
Shear:						
No shear reinforcement ²	30	15	30	15	30	15
Reinforcement taking entire shear						
Flexural members.....	100	50	100	50	100	50
Shear Walls	60	30	60	30	60	30
Modulus of Elasticity ³	1,800,000	900,000	1,500,000	750,000	1,350,000	675,000
Modulus of Rigidity ³	720,000	360,000	600,000	300,000	540,000	270,000
Bearing on full area ⁴	450	225	375	187	340	170
Bearing on $\frac{1}{2}$ or less of area ⁴	540	270	450	225	400	200
Bond—Plain bars.....	60	30	60	30	60	30
Bond—Deformed.....	140	100	140	100	140	100

¹Stresses are based on net section.²Web reinforcement shall be provided to carry the entire shear in excess of 20 pounds per square inch whenever there is required negative reinforcement and for a distance of one-sixteenth the clear span beyond the point of inflection.³Where determinations involve rigidity considerations in combination with other materials or where deflections are involved the moduli of elasticity and rigidity under columns entitled "yes" for special inspection shall be used.⁴This increase shall be permitted only when the least distance between the edges of the loaded and unloaded areas is a minimum of one-fourth of the parallel side dimension of the loaded area. The allowable bearing stress on a reasonably concentric area greater than one-third, but less than the full area, shall be interpolated between the values given.

of the masonry, with consideration for reductions such as raked joints.

The thickness of masonry walls shall be designed so that allowable maximum stresses specified in this Chapter are not exceeded and so that all masonry walls shall not exceed the height or length to thickness ratio nor the minimum thickness as specified in this Chapter and as set forth in Table No. 24-J.

EXCEPTION: The height or length to thickness ratio may be increased and the minimum thickness may be decreased when data is submitted which justifies a reduction in the requirements specified in this Section.

(c) **Piers.** Every structural pier whose width is less than three times its thickness shall be designed and constructed as required for columns.

(d) **Chases and Recesses.** Chases and recesses in masonry walls shall be designed and constructed so as not to reduce the required strength or required fire resistance of the wall.

(e) **Pipes and Conduits Embedded in Masonry.** No pipe or conduit shall be embedded in any structural masonry necessary for structural stability or required fire protection.

TABLE NO. 24-I—MAXIMUM WORKING STRESSES FOR REINFORCED SOLID AND HOLLOW UNIT MASONRY BASED ON SPECIAL TESTS

TYPE OF STRESS ¹	SOLID AND HOLLOW UNITS	
	Special Testing ²	
	f'_m as Established by Tests	
SPECIAL INSPECTION REQUIRED.....	YES	
Compression—Axial, Walls.....	See Section 2418	
Compression—Axial, Columns.....	See Section 2420	
Compression—Flexural.....	.33 f'_m but not to exceed	900
Shear:		
No shear reinforcement ³	.02 f'_m but not to exceed	50
Reinforcement taking entire shear.....		
Flexural members.....	.05 f'_m but not to exceed	120
Shear Walls.....	.04 f'_m but not to exceed	75
Modulus of Elasticity ⁴	1000 f'_m but not to exceed	3,000,000
Modulus of Rigidity ⁴	400 f'_m but not to exceed	1,200,000
Bearing on full area ⁵	.25 f'_m but not to exceed	900
Bearing on $\frac{1}{3}$ or less of area ⁵	.30 f'_m but not to exceed	1,200
Bond—Plain bars.....		60
Bond—Deformed.....		140

¹For footnotes 1, 3, 4 and 5; see footnotes 1, 2, 3 and 4 respectively of Table No. 24-I.

²Special testing shall include preliminary tests conducted as specified in Section 2404 (c) to establish f'_m and at least one field test during construction of walls per each five thousand square feet (5000 sq. ft.) of wall but not less than three such field tests for any building.

**General
Design
(Continued)**

EXCEPTIONS: 1. Rigid electric conduits may be embedded in structural masonry when their location has been detailed on the approved plans.

2. Any pipe or conduit may pass vertically or horizontally through any masonry by means of a sleeve at least large enough to pass any hub or coupling on the pipe line. Such sleeves shall be placed not closer than three diameters, center-to-center, nor shall they unduly impair the strength of construction.

3. Placement of pipes or conduits in unfilled cores of hollow unit masonry shall not be considered as embedment.

(f) **Arches and Lintels.** Members supporting masonry shall be of incombustible materials.

(g) **Anchorage.** Masonry walls that meet or intersect shall be bonded or anchored as required in Section 2313.

Structural members framing into or supported by walls or columns shall be anchored.

(h) **Combined Axial and Flexural Stresses.** Members subject to combined axial and flexural stresses shall be so proportioned that the quantity

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \text{ shall not exceed } 1$$

WHERE:

f_a = Computed axial unit stress, determined from total axial load and effective area.

F_a = Axial unit stress permitted by this Code at the point under consideration, if member were carrying axial load only, including any increase in stress allowed by this Section.

f_b = Computed flexural unit stress.

F_b = Flexural unit stress permitted by this Code, if member were carrying bending load only, including any increase in stress allowed by this Section.

(i) **Allowable Reduction of Bending Stress by Vertical Load.** In calculating maximum tensile fiber stress due to lateral forces other than earthquake forces, the maximum tensile fiber stress may be reduced by the direct stress due to vertical dead loads. In calculating maximum tensile fiber stress due to earthquake forces, the maximum tensile fiber stress may be reduced by not more than 50 per cent of the direct stress due to vertical dead loads.

(j) **Unreinforced Masonry.** Design and construction of elements of plain masonry shall be such that unit stresses do not exceed those set forth in tables in this Chapter for the various masonry units.

(k) **Partially Reinforced Masonry.** Partially reinforced masonry shall be designed as unreinforced masonry, except that

TABLE NO. 24-J—MINIMUM THICKNESS OF MASONRY WALLS

General
Design
(Continued)

TYPE OF MASONRY	MAXIMUM RATIO UNSUPPORTED HEIGHT OR LENGTH TO THICKNESS	NOMINAL MINIMUM THICKNESS (Inches)
BEARING WALLS:		
Unburned Clay Masonry	10	16
Stone Masonry	14	16
Cavity Wall Masonry	18	8
Hollow Unit Masonry	18	8
Solid Masonry	20	8
Grouted Masonry	20	7
Reinforced Grouted Masonry	25	6
Reinforced Hollow Unit Masonry	25	6
NONBEARING WALLS:		
Exterior Unreinforced Walls	20	2
Exterior Reinforced Walls	30	2
Interior Partitions Unreinforced	36	2
Interior Partitions Reinforced	48	2

reinforced areas or elements may be considered as resisting stresses in accordance with the design criteria set forth in Section 2418 provided such elements fully comply with the design and construction requirements for reinforced masonry except as herein noted. Only Type S mortar shall be used.

The minimum area of reinforcement required in Section 2418 (f) 3 shall not apply to partially reinforced masonry walls. Maximum spacing of vertical reinforcement in exterior partially reinforced masonry walls shall be eight feet (8'). Reinforcement shall be provided each side of each opening and at each corner of all walls. Horizontal reinforcement not less than 0.2 square inches in area shall be provided at the top of footings, at the bottom and top of wall openings, near roof and floor levels and at the top of parapet walls.

(1) **Allowable Masonry Stresses.** All reinforced masonry shall be so designed and constructed that the unit stresses do not exceed those set forth in Table No. 24-H.

Allowable stresses may be determined by preliminary tests as specified in Section 2404 (c), and shall not exceed those specified in Table No. 24-I.

Reinforced masonry design shall be in accordance with the procedures set forth in Chapter 26 of this Code except as specified in this Chapter.

All plans submitted for approval shall clearly show the assumed strength of masonry for which all parts of the structure were designed.

(m) **Allowable Steel Stresses.** The unit stresses in reinforcement shall not exceed those specified for reinforcement in concrete.

**General
Design
(Continued)**

(n) **Bolt Values.** The allowable loads on bolts shall not exceed the values set forth in Table No. 24-C.

(o) **Stack Bond.** Where masonry units are laid in stack bond in plain masonry mechanical bond shall be provided by placing one continuous No. 9 gauge wire or its equivalent in the horizontal bed joint for each four-inch (4") thickness of the masonry unit and spaced not more than sixteen inches (16") on centers vertically.

**Bearing
Walls**

Sec. 2418. (a) General. Masonry walls shall be designed as specified in Section 2417 and to withstand all vertical and horizontal loads as specified in Chapter 23, and with due allowance for the effect of eccentric loads.

(b) **End Support.** Beams, girders, or other concentrated loads supported by a wall or pier shall have bearing at least three inches (3") in length upon solid masonry not less than four inches (4") thick or upon a metal bearing plate of adequate design and dimensions to distribute the loads safely on the wall or pier, or upon a continuous reinforced masonry member projecting not less than three inches (3") from the face of the wall, or by other approved methods.

Joists shall have bearing at least three inches (3") in length upon solid masonry at least two and one-fourth inches (2¼") thick; or other provisions shall be made to distribute safely the loads on the wall or pier.

(c) **Width in Flexural Computations.** In computing flexural stresses where reinforcement occurs, the effective width shall be not greater than four times the wall thickness in solid masonry nor more than one and one-half times the unit length in hollow masonry.

(d) **Distribution of Concentrated Loads.** In calculating wall stresses, concentrated loads may be distributed over a maximum length of wall not exceeding the center-to-center distance between loads.

Where the concentrated loads are not distributed through a structural element, the length of wall considered shall not exceed the width of the bearing plus four times the wall thickness.

Concentrated loads shall not be considered as distributed by metal ties, nor distributed across continuous vertical joints.

(e) **Plain Masonry Walls.** 1. **Ratio of height or length to thickness.** The ratio of unsupported height to thickness or the ratio of unsupported length to thickness (one or the other but not both) for solid masonry walls or bearing partitions shall not exceed 20, and shall not exceed 18 for walls of hollow masonry or cavity walls. In computing the ratio for cavity walls, the value for thickness shall be the sum of the nominal thicknesses of the inner and outer widths of the masonry. In walls composed of different kinds or classes of units or mortars, the ratio of height or length to thickness shall not exceed that

allowed for the weakest of the combination of units and mortars of which the member is composed.

2. **Minimum thickness.** The minimum thickness of bearing walls of plain masonry shall be twelve inches (12") for the uppermost thirty-five feet (35') of their height, and shall be increased four inches (4") in thickness for each successive thirty-five feet (35') or fraction thereof measured downward from the top of the wall.

EXCEPTIONS: 1. The top story walls of a building not exceeding three stories or thirty-five feet (35') in height, or the walls of a one-story building, may have a wall thickness equal to eight inches (8").

2. The thickness of unreinforced grouted brick masonry walls may be two inches (2") less than required by this Subsection, but in no case less than seven inches (7") except in one-story dwellings.

3. In Group I Occupancies not more than three stories in height, masonry walls may be of eight inches (8") nominal thickness when not over thirty-five feet (35') in height. Solid masonry walls in one-story single-family and one-story multiple-family dwellings, one-story motels and one-story garages may be of six-inch (6") nominal thickness when not over nine feet (9') in height, provided that when gable construction is used an additional six feet (6') is permitted to the peak of the gable.

When a change in thickness due to minimum thickness requirements occurs between floor levels, the greater thickness shall be carried to the higher floor level.

3. **Stresses.** The axial stress in unreinforced bearing walls, or portions thereof, shall not exceed the values set forth in Table No. 24-B. Bolt values shall not exceed those set forth in Table No. 24-C.

(f) **Reinforced Masonry Walls.** 1. **Minimum thickness.** The minimum nominal thickness of reinforced masonry bearing walls shall be six inches (6"), and the ratio of height or length to thickness shall not exceed 25, except as specified in Section 2417 (b).

2. **Stresses.** The axial stress in reinforced masonry bearing walls shall not exceed the value determined by the following formula:

$$f_m = 0.20 f'_m \left[1 - \left(\frac{h}{30t} \right)^3 \right]$$

WHERE:

f_m = Compressive unit axial stress in masonry wall.

f'_m = Ultimate compressive masonry stress as determined by Section 2404 (c) or as specified in Table No. 24-H. The value of " f'_m " shall not exceed 3500 pounds per square inch.

**Bearing
Walls
(Continued)**

**Bearing
Walls
(Continued)** t = Thickness of wall in inches. h = Clear height in inches.

3. **Reinforcement.** All walls using stress permitted for reinforced masonry shall be reinforced with both vertical and horizontal bars.

The minimum area of total reinforcement shall be not less than 0.002 times the gross cross-sectional area of the wall, not more than two-thirds of which may be used in either direction. Principal wall steel shall be limited to the maximum spacing of four feet (4') on center. The minimum diameter shall be three-eighths inch ($\frac{3}{8}$ ") except that approved wire reinforcement used as temperature steel or to replace running bond may be considered as part of the required reinforcement.

Horizontal reinforcement shall be provided in the top of footings, at the top of wall openings, at roof and floor levels, and at the top of parapet walls. Only horizontal reinforcement which is continuous in the wall shall be considered in computing the minimum area of reinforcement.

If the wall is constructed of more than two units in thickness, the minimum area of required reinforcement shall be equally divided into two layers, except where designed as retaining walls. Where reinforcement is added above the minimum requirements such additional reinforcement need not be so divided.

In bearing walls of every type of reinforced masonry there shall be not less than one one-half-inch ($\frac{1}{2}$ ") bar or two three-eighths-inch ($\frac{3}{8}$ ") bars on all sides of, and adjacent to, every opening which exceeds twenty-four inches (24") in either direction, and such bars shall extend not less than 40 diameters, but in no case less than twenty-four inches (24") beyond the corners of the opening. The bars required by this paragraph shall be in addition to the minimum reinforcement elsewhere required.

**Nonbearing
Walls**

Sec. 2419. (a) General. Nonbearing walls may be constructed of any masonry as specified in this Chapter.

(b) **Thickness.** Every nonbearing masonry wall shall be so constructed and have a sufficient thickness to withstand all vertical loads and horizontal loads, where specifically required by Chapter 23, but in no case shall the thickness of such walls (including plaster when applied) be less than the values set forth in Table No. 24-J.

(c) **Wire-mesh Reinforcement.** Wire-mesh reinforcement may be used to resist tensile stresses when embedded in plaster applied to the surface of any nonbearing wall. Wire-mesh reinforcement shall conform to the requirements of Chapter 26, and plaster shall conform to the requirements of Chapter 47.

(d) **Anchorage.** All nonbearing partitions shall be anchored along the top edge to a structural member or a suspended ceiling, or shall be provided with equivalent anchorage along the sides. **Nonbearing Walls (Continued)**

All exterior nonbearing walls shall be anchored along all edges to structural members.

Sec. 2420. (a) General. Masonry columns shall be constructed of reinforced masonry and as required by this Section. **Columns**

(b) **Limiting Dimensions.** The least dimension of every masonry column shall be not less than twelve inches (12"), unless designed for one-half the allowable stresses, in which case the minimum least dimensions shall be eight inches (8"). No masonry column shall have an unsupported length greater than 20 times its least dimension.

(c) **Allowable Loads.** The axial load on columns shall not exceed:

$$P = A_g (.18 f'_m + 0.65 P_g f_s) \left[1 - \left(\frac{h}{30t} \right)^2 \right]$$

WHERE:

P = Maximum concentric column axial load.

A_g = The gross area of the column.

f'_m = Ultimate compressive masonry strength as determined by Section 2404 (c) or as specified in Table No. 24-H. The value of " f'_m " shall not exceed 3500 pounds per square inch.

P_g = Ratio of the effective cross-sectional area of vertical reinforcement to " A_g ."

f_s = See Section 2622 (c).

t = Least thickness of column in inches.

h = Clear height in inches.

(d) **Reinforcement. 1. Vertical reinforcement.** The ratio " P_g " shall be not less than 0.5 per cent nor more than four per cent. The number of bars shall be not less than four, nor the diameter less than three-eighths inch ($\frac{3}{8}$ ").

Where lapped splices are used, the amount of lap shall be sufficient to transfer the working stress by bond, but in no case shall the length of lapped splice be less than 30 bar diameters, and welded splices shall be full butt welded.

2. **Ties.** Lateral ties shall be at least one-fourth inch ($\frac{1}{4}$ ") in diameter and shall be spaced apart not over 16 bar diameters, 48 tie diameters, or the least dimension of the column. Lateral ties shall be placed not less than one and one-half inches ($1\frac{1}{2}$ ") and not more than five inches (5") from the surface of the column, and may be against the vertical bars, or placed in the horizontal bed joints.

CHAPTER 25—WOOD

General

Sec. 2501. (a) **Quality and Design.** The quality and design of wood members and their fastenings used for load-supporting purposes shall conform to the provisions of this Chapter, and to the following standards:

MATERIALS AND DESIGN	U.B.C. DESIGNATION
GRADING—LIGHT FRAMING, JOISTS AND PLANKS, DECKING, BEAMS AND STRINGERS, POSTS AND TIMBERS	
All Species of Lumber.....	25- 1-64
Cedar, Incense and Western Red.....	{25- 3-64 25- 4-64
Cypress—Tidewater Red.....	25- 2-64
Douglas Fir, Coast Region.....	25- 3-64
Douglas Fir	25- 4-64
Fir, White.....	{25- 3-64 25- 4-64
Fir, Balsam	25- 8-64
Hemlock, Eastern	25- 5-64
Hemlock, West Coast.....	25- 3-64
Hemlock, Western	25- 4-64
Larch	25- 4-64
Pine (Idaho White, Lodgepole, Ponderosa and Sugar.....	25- 4-64
Pine, Norway	25- 5-64
Pine, Southern	25- 6-64
Redwood	25- 7-64
Spruce, Eastern	25- 8-64
Spruce, Engelmann	25- 4-64
Spruce, Sitka	25- 3-64
PLYWOOD—DOUGLAS FIR AND WESTERN SOFTWOOD	25- 9-64
STRUCTURAL GLUED-LAMINATED WOOD	
All Species of Lumber.....	25-10-64
Douglas Fir.....	25-11-64
Pine, Southern.....	25-11-64
Hardwood	25-11-64
Hemlock, West Coast.....	25-11-64
Larch	25-11-64
TREATED WOOD	25-12-64
WOOD POLES	25-13-64
ROUND TIMBER PILES	25-14-64
SPACED COLUMNS	25-15-64
FLEXURAL AND AXIAL LOADING	25-16-64
JOINTS	
Timber Connectors.....	25-17-64
Bolts	25-17-64
Drift Bolt and Wood Screws.....	25-17-64
Lag Screws	25-17-64
FLAT PANELS WITH STRESSED COVERINGS	25-18-64

ADHESIVES	25-19-64	General (Continued)
TEST FOR GLUE JOINTS.....	25-20-64	
GENERAL DESIGN CRITERIA.....	25-21-64	
PLANK AND BEAM CONSTRUCTION.....	25-22-64	

(b) **Workmanship.** All members shall be framed, anchored, tied, and braced so as to develop the strength and rigidity necessary for the purposes for which they are used.

(c) **Fabrication.** Preparation, fabrication, and installation of wood members, and glues and mechanical devices for the fastening thereof, shall conform to good engineering practices.

(d) **Rejection.** The Building Official may deny permission for the use of a wood member where permissible grade characteristics or defects are present in any wood member in such a combination that they affect the serviceability of the member.

Sec. 2502. Except where otherwise provided, the following terms and symbols used in this Chapter have the meaning indicated in this Section:

**Definitions
and
Notations**

GLUED-LAMINATED LUMBER, lumber composed of an assembly of wood laminations bonded with adhesives in which the laminations are too thick to be classed as veneers. See definition of Structural Glued-laminated Lumber.

GLUED BUILT-UP MEMBERS, structural members, the sections of which are composed of combinations of sawn lumber or plywood, or glued-laminated lumber, in which all parts are bonded together with adhesives.

GRADE (Lumber), the classification of lumber in regard to strength and utility in accordance with U.B.C. Standards Nos. 25-1-64 to 25-8-64.

GRADE—STRESS (Lumber), a lumber grade defined in such terms that a definite working stress may be assigned to it as set forth in U.B.C. Standard No. 25-1-64.

NOMINAL SIZE (Lumber), the commercial size designation of width, and depth, in standard sawn lumber and glued-laminated lumber grades; somewhat larger than the standard net size of dressed lumber, in accordance with U.B.C. Standard No. 25-1-64 for sawn lumber and U.B.C. Standard No. 25-10-64 or No. 25-11-64 for glued-laminated lumber.

NORMAL LOADING, a design load that stresses a member or fastening to the full allowable stress tabulated in this Chapter. This loading may be applied for approximately 10 years, either continuously or cumulatively, and 90 per cent of this full maximum design load may be applied for the remainder of the life of the structure. See U.B.C. Standard No. 25-1-64.

**Definitions
and
Notations
(Continued)**

PLYWOOD—DOUGLAS FIR AND WESTERN SOFT-WOOD, a built-up board of laminated veneers conforming to U.B.C. Standard No. 25-9-64.

STRUCTURAL GLUED-LAMINATED LUMBER, any member comprising an assembly of laminations of lumber in which the grain of all laminations is approximately parallel longitudinally; in which the laminations are bonded with adhesives; and which is fabricated in accordance with U.B.C. Standard No. 25-10-64 or No. 25-11-64.

SYMBOLS AND NOTATIONS, as used in these regulations, are defined as follows:

- A = area in square inches of net cross section.
- b = breadth of beam or of cross section in inches.
- c = compression parallel to grain, allowable unit stress in pounds per square inch.
- d = least dimension of column, in inches.
- E = modulus of elasticity.
- f = extreme fiber in bending, allowable unit stress in pounds per square inch.
- h = depth of section, in inches.
- H = horizontal shear, allowable unit stress in pounds per square inch.
- I = moment of inertia of member.
- l = span in inches or laterally unsupported length of a column in inches.
- N = allowable unit stress on inclined surface in pounds per square inch.
- P = total load in pounds.
- q = compression perpendicular to grain, allowable unit stress in pounds per square inch.
- R = reaction, in pounds.
- t = tension parallel to grain, allowable unit stress in pounds per square inch.
- V = vertical shear at section under consideration.
- l/d = ratio of length to least dimension.
- P/A = compressive strength or maximum axial load, in pounds per square inch.
- θ = angle between direction of load and the direction of grain, in degrees.

TREATED WOOD. Pressure treatment or the term "pressure impregnated with an approved preservative" is that treatment of wood which is in accordance with U.B.C. Standard No. 25-12-64.

Sec. 2503. (a) Required Sizes. Wood members shall be of sufficient size to carry the dead and required live loads without exceeding the allowable unit stresses as hereinafter specified.

**Size of
Structural
Members**

(b) Size Determination. Minimum sizes of lumber and glued-laminated members required by this Code refer to nominal sizes. U.B.C. Standards No. 25-1-64 for lumber, and No. 25-10-64 or No. 25-11-64 for glued-laminated dressed sizes shall be accepted as the minimum net sizes conforming to nominal sizes. Nominal sizes may be shown on the plans. Computations to determine the required sizes of members shall be based on the net dimensions (actual sizes) and not the nominal sizes. If rough sizes or sizes or shapes other than U.B.C. Standards Nos. 25-1-64 or 25-11-64 dressed sizes are to be used, the actual net sizes shall be specified on the plans.

Sec. 2504. (a) Allowable Unit Stress on Plans. Where structures are designed for use of stress grade lumber, structural glued-laminated lumber, for plywood used structurally, the allowable unit stresses or the species and the grade shall be shown on the plans filed with the Building Department.

**Allowable
Unit Stresses**

(b) Stresses. 1. General. Except as hereinafter provided, stresses shall not exceed the allowable unit stresses in pounds per square inch for the respective species and grades and grade combinations as set forth in Table No. 25-A for solid sawn stress-grade lumber; Tables No. 25-B and No. 25-C for Douglas fir plywood; and Tables No. 25-D, No. 25-E and No. 25-F for structural glued-laminated lumber.

For modification of allowable unit stresses for structural glued-laminated lumber, see also Section 2513.

The allowable unit stresses in extreme fiber in bending "*f*" as set forth in Tables No. 25-D and No. 25-F apply to members with the wide face of the lamination perpendicular to the direction of the load. When the wide face of the lamination is parallel to the direction of the load, the bending stresses as set forth in Table No. 25-A shall apply, except as provided in Table No. 25-E.

The allowable unit stresses as set forth in Tables No. 25-A, No. 25-D, No. 25-E and No. 25-F and adjustments thereof, and stresses as set forth in Tables No. 25-B and No. 25-C, apply also to lumber, to structural glued-laminated lumber, and to exterior type plywood that have been pressure-impregnated by an approved preservative.

Studs, joists, rafters, foundation plates or sills, planking two inches (2") or more in depth, beams, stringers, posts, structural sheathing and similar load-bearing members shall be of at least the minimum grades set forth in Table No. 25-A and in Groups I, II, and III set forth in Table No. 25-G. Lumber set forth in Group IV of Table No. 25-G may be used only under conditions specifically approved by the Building Official.

(Continued on page 169)

TABLE NO. 25-A—ALLOWABLE UNIT STRESSES FOR STRESS-GRADE LUMBER*

Normal Loading—See also Section 2504 (d) and (e)

†ABBREVIATIONS: J.&P.: Joists and Planks; B.&S.: Beams and Stringers; P.&T.: Posts and Timbers; L.F.: Light Framing; K.D.: Kiln Dried; S.R.: Stress Rated.

SPECIES AND COMMERCIAL GRADE	SYMBOL:†	ALLOWABLE UNIT STRESSES, POUNDS PER SQUARE INCH					RULES UNDER WHICH GRADED
		Extreme Fiber in Bending (and Tension Parallel to Grain)	Maximum Horizontal Shear	Compression Perpendicular to Grain	Compression Parallel to Grain	Modulus of Elasticity	
		f (or f')	H	q	c	E^a	
DOUGLAS FIR, COAST REGION							
Dense Select Structural	L.F.	2050	120 ²⁻³⁻⁵	455	1500		
Select Structural	L.F.	1900	120 ²⁻³⁻⁵	415	1400		
1750f.-Industrial	L.F.	1750	120	455	1400		
1500f.-Industrial	L.F.	1500	120	390	1200		
1200f.-Industrial	L.F.	1200	95	390	1000		
Dense Select Structural	J. & P.	2050	120 ²⁻³⁻⁵	455	1650		
Select Structural	J. & P.	1900	120 ²⁻³⁻⁵	415	1500		
Dense Construction	J. & P.	1750	120 ²⁻⁴⁻⁵	455	1400		
Construction	J. & P.	1500	120 ²⁻⁴⁻⁵	390	1200		
Standard	J. & P.	1200	95 ²⁻⁴⁻⁵	390	1000		
Dense Select Structural	B. & S.	2050	120 ⁷	455	1500		
Select Structural	B. & S.	1900	120 ⁷	415	1400		
Dense Construction	B. & S.	1750	120 ⁷	455	1200		
Construction	B. & S.	1500	120 ⁷	390	1000		
Dense Select Structural	P. & T.	1900	120 ⁷	455	1650		
Select Structural	P. & T.	1750	120 ⁷	415	1500		
Dense Construction	P. & T.	1500	120 ⁷	455	1400		
Construction	P. & T.	1200	120 ⁷	390	1200		
						(All) 1,600,000	U.B.C. Standard No. 25-3-64

*For explanatory footnotes see pages 156-157.

TABLE NO. 25-A—ALLOWABLE UNIT STRESSES FOR STRESS-GRADE LUMBER

SPECIES AND COMMERCIAL GRADE	SYMBOL:†	ALLOWABLE UNIT STRESSES, POUNDS PER SQUARE INCH					RULES UNDER WHICH GRADED
		Extreme Fiber in Bending (and Tension Parallel to Grain)	Maximum Horizontal Shear	Compression Perpendicular to Grain	Compression Parallel to Grain	Modulus of Elasticity	
		f (or f')	H	q	c	E^A	
HEMLOCK, WEST COAST							
Select Structural	L.F.	1600	100 ²⁻³⁻⁹	365	1100		
1500f.-Industrial	L.F.	1500	100	365	1000		
1200f.-Industrial	L.F.	1200	80	365	900		
Select Structural	J. & P.	1600	100 ²⁻³⁻⁹	365	1200	(All)	U.B.C.
Construction	J. & P.	1500	100 ²⁻⁸⁻⁹	365	1100	1,400,000	Standard
Standard	J. & P.	1200	80 ²⁻⁸⁻⁹	365	1000		No. 25-3-64
Construction	B. & S.	1500	100 ¹⁰	365	1000		
Construction	P. & T.	1200	100 ¹⁰	365	1100		
DOUGLAS FIR, COAST REGION							
Select Dex	Decking	1500	—	390	—	1,600,000	U.B.C.
Commercial Dex	Decking	1200	—	390	—	1,600,000	Standard
HEMLOCK, WEST COAST							
Select Dex	Decking	1300	—	365	—	1,400,000	U.B.C.
Commercial Dex	Decking	1000	—	365	—	1,400,000	Standard
SPRUCE, SITKA							
Select Dex	Decking	1100	—	305	—	1,200,000	U.B.C.
Commercial Dex	Decking	850	—	305	—	1,200,000	Standard
CEDAR, INCENSE							
Select Dex	Decking	1100	—	305	—	900,000	U.B.C.
Commercial Dex	Decking	850	—	305	—	900,000	Standard

TABLE NO. 25-A--ALLOWABLE UNIT STRESSES FOR STRESS-GRADE LUMBER (Continued)

SPECIES AND COMMERCIAL GRADE	SYMBOL:†	ALLOWABLE UNIT STRESSES, POUNDS PER SQUARE INCH					RULES UNDER WHICH GRADED
		Extreme Fiber in Bending (and Tension Parallel to Grain)	Maximum Horizontal Shear	Compression Perpendicular to Grain	Compression Parallel to Grain	Modulus of Elasticity	
		f (or f')	H	q	c	E^6	
CEDAR, WESTERN RED							U.B.C. Standard No. 25-3-64
Select Dex	Decking	900	—	240	—	1,000,000	
Commercial Dex	Decking	700	—	240	—	1,000,000	
FIR, WHITE							U.B.C. Standard No. 25-3-64
Select Dex	Decking	1100	—	365	—	1,100,000	
Commercial Dex	Decking	850	—	365	—	1,100,000	
DOUGLAS FIR AND LARCH ¹⁷							
Dense Select Structural MC15**	L.F. ¹⁶	2300	135 ²⁻³⁻⁵	455	1700	(All) 1,600,000	U.B.C. Standard No. 25-4-64
Select Structural MC15	L.F. ¹⁶	2100	135 ²⁻³⁻⁵	415	1550		
Dense Select Structural	L.F.	2050	120 ²⁻³⁻⁵	455	1500		
Select Structural	L.F.	1900	120 ²⁻³⁻⁵	415	1400		
1750f. Industrial MC15	L.F.	2050	135	455	1600		
1750f. Industrial	L.F.	1750	120	455	1400		
1500f. Industrial MC15	L.F. ¹⁶	1750	135	390	1400		
1500f. Industrial	L.F.	1500	120	390	1200		
1200f. Industrial MC15	L.F. ¹⁶	1500	110	390	1200		
1200f. Industrial	L.F.	1200	95	390	1000		
Dense Select Structural MC15	J. & P. ¹⁶	2300	135 ²⁻³⁻⁵	455	1850		
Select Structural MC15	J. & P. ¹⁶	2100	135 ²⁻³⁻⁵	415	1650		
Dense Select Structural	J. & P.	2050	120 ²⁻³⁻⁵	455	1650		
Dense Construction MC15	J. & P. ¹⁶	2050	135 ²⁻⁴⁻⁵	455	1600		
Select Structural	J. & P.	1900	120 ²⁻³⁻⁵	415	1500		
Dense Construction	J. & P.	1750	120 ²⁻⁴⁻⁵	455	1400		
Construction MC15	J. & P. ¹⁶	1750	135 ²⁻¹⁻⁵	390	1400		
Construction	J. & P.	1500	120 ²⁻⁴⁻⁵	390	1200		

**Grades designated as MC15 are required to have a maximum moisture content of 15 per cent.

TABLE NO. 25-A—ALLOWABLE UNIT STRESSES FOR STRESS-GRADE LUMBER (Continued)

SPECIES AND COMMERCIAL GRADE	SYMBOL: [†]	ALLOWABLE UNIT STRESSES, POUNDS PER SQUARE INCH					RULES UNDER WHICH GRADED
		Extreme Fiber in Bending (and Tension Parallel to Grain)	Maximum Horizontal Shear	Compression Perpendicular to Grain	Compression Parallel to Grain	Modulus of Elasticity	
		f (or f')	H	q	c	E^0	
DOUGLAS FIR AND LARCH							
Standard MC15	J. & P. ¹⁶	1500	110 ²⁻⁴⁻⁵	390	1200	(All) 1,600,000	U.B.C. Standard No. 25-4-64
Standard	J. & P.	1200	95 ²⁻⁴⁻⁵	390	1000		
Dense Select Structural	B. & S.	2050	120 ⁷	455	1500		
Select Structural	B. & S.	1900	120 ⁷	415	1400		
Dense Construction	B. & S.	1750	120 ⁷	455	1200		
Construction	B. & S.	1500	120 ⁷	390	1000		
Dense Select Structural	P. & T.	1900	120 ⁷	455	1650		
Select Structural	P. & T.	1750	120 ⁷	415	1500		
Dense Construction	P. & T.	1500	120 ⁷	455	1400		
Construction	P. & T.	1200	120 ⁷	390	1200		
HEMLOCK, WESTERN							
Select Structural MC15	L.F. ¹⁶	1800	115 ²⁻³⁻⁹	365	1200	(All) 1,400,000	U.B.C. Standard No. 25-4-64
Select Structural	L.F.	1600	100 ²⁻³⁻⁹	365	1100		
1500f. Industrial MC15	L.F. ¹⁶	1650	115	365	1150		
1500f.-Industrial	L.F.	1500	100	365	1000		
1200f. Industrial MC15	L.F. ¹⁶	1450	90	365	1050		
1200f.-Industrial	L.F.	1200	80	365	900		
Select Structural MC15	J. & P. ¹⁶	1800	115 ²⁻³⁻⁹	365	1300		
Select Structural	J. & P.	1600	100 ²⁻³⁻⁹	365	1200		
Construction MC15	J. & P. ¹⁶	1650	115 ²⁻⁸⁻⁹	365	1250		
Construction	J. & P.	1500	100 ²⁻⁸⁻⁹	365	1100		
Standard MC15	J. & P. ¹⁶	1450	90 ²⁻⁸⁻⁹	365	1150		
Standard	J. & P.	1200	80 ²⁻⁸⁻⁹	365	1000		
Construction	B. & S.	1500	100 ¹⁰	365	1000		
Construction	P. & T.	1200	100 ¹⁰	365	1100		

TABLE NO. 25-A—ALLOWABLE UNIT STRESSES FOR STRESS-GRADE LUMBER (Continued)

SPECIES AND COMMERCIAL GRADE	SYMBOL:†	ALLOWABLE UNIT STRESSES, POUNDS PER SQUARE INCH					RULES UNDER WHICH GRADED
		Extreme Fiber in Bending (and Tension Parallel to Grain)	Maximum Horizontal Shear	Compression Perpendicular to Grain	Compression Parallel to Grain	Modulus of Elasticity	
		f (or f')	H	q	c	E^a	
DOUGLAS FIR AND LARCH Selected Decking Commercial Decking	Decking Decking	1500 1200	— —	390 390	— —	1,600,000 1,600,000	U.B.C. Standard No. 25-4-64
WHITE FIR Selected Decking Commercial Decking	Decking Decking	1100 850	— —	365 365	— —	1,100,000 1,100,000	U.B.C. Standard No. 25-4-64
PINE, NORWAY Prime Structural Common Structural Utility Structural	J. & P. ^{15, 16} J. & P. ^{15, 16} J. & P. ^{15, 16}	1200 1100 950	75 75 75	360 360 360	900 775 650	1,200,000 1,200,000 1,200,000	U.B.C. Standard No. 25-5-64
PINE (IDAHO WHITE, LODGEPOLE, PONDEROSA AND SUGAR) Selected Decking Commercial Decking	Decking Decking	900 700	— —	305 305	— —	1,000,000 1,000,000	U.B.C. Standard No. 25-4-64
CEDAR, INCENSE AND WESTERN RED Selected Decking Commercial Decking	Decking Decking	900 700	— —	240 240	— —	1,000,000 1,000,000	U.B.C. Standard No. 25-4-64
SPRUCE, ENGELMANN Selected Decking Commercial Decking	Decking Decking	750 600	— —	215 215	— —	1,000,000 1,000,000	U.B.C. Standard No. 25-4-64

TABLE NO. 25-A—ALLOWABLE UNIT STRESSES FOR STRESS-GRADE LUMBER (Continued)

SPECIES AND COMMERCIAL GRADE		ALLOWABLE UNIT STRESSES, POUNDS PER SQUARE INCH					RULES UNDER WHICH GRADED
		Extreme Fiber in Bending (and Tension Parallel to Grain)	Maximum Horizontal Shear	Compression Perpendicular to Grain	Compression Parallel to Grain	Modulus of Elasticity	
	SYMBOL:†	f (or f')	H	q	c	E^a	
HEMLOCK, WESTERN Selected Decking Commercial Decking	Decking Decking	1300 1000	— —	365 365	— —	1,400,000 1,400,000	U.B.C. Standard No. 25-4-64
HEMLOCK, EASTERN Select Structural Prime Structural Common Structural Utility Structural Select Structural	J. & P. ¹⁵ -B. & S. ¹⁵ J. & P. ¹⁵⁻¹⁶ J. & P. ¹⁵⁻¹⁶ J. & P. ¹⁵⁻¹⁶ P. & T.	1300 1200 1100 950 —	85 60 60 60 —	360 360 360 360 360	850 775 650 600 850	(All) 1,100,000	U.B.C. Standard No. 25-5-64
PINE, SOUTHERN Select Select No. 1 No. 2	Decking Decking Decking	1500 1200 1200	105 105 105	390 390 390	1250 900 900	(All) 1,600,000	U.B.C. Standard No. 25-6-64
PINE, SOUTHERN ¹¹ Dense Structural 86 KD ¹³⁻¹⁴ Dense Structural 72 KD ¹³⁻¹⁴ Dense Structural 65 KD ¹³⁻¹⁴ Dense Structural 58 KD ¹³⁻¹⁴ No. 1 Dense KD ¹³⁻¹⁴ No. 1 KD ¹³ No. 2 Dense KD ¹³⁻¹⁴ No. 2 KD ¹³	2" thick only	3000 2500 2250 2050 2050 1750 1750 1500	165 150 135 120 135 135 120 120	455 455 455 455 455 390 455 390	2250 1950 1800 1650 1750 1500 1300 1100	(All) 1,600,000	U.B.C. Standard No. 25-6-64

TABLE NO. 25-A—ALLOWABLE UNIT STRESSES FOR STRESS-GRADE LUMBER (Continued)

SPECIES AND COMMERCIAL GRADE	SYMBOL†	ALLOWABLE UNIT STRESSES, POUNDS PER SQUARE INCH					RULES UNDER WHICH GRADED
		Extreme Fiber in Bending (and Tension Parallel to Grain)	Maximum Horizontal Shear	Compression Perpendicular to Grain	Compression Parallel to Grain	Modulus of Elasticity	
		f (or f')	H	q	c	E^A	
PINE, SOUTHERN ¹							
Dense Structural 86 ¹⁴	2" thick only	2900	150	455	2200		
Dense Structural 72 ¹⁴		2350	135	455	1800		
Dense Structural 65 ¹⁴		2050	120	455	1600		
Dense Structural 58 ¹⁴		1750	105	455	1450		
No. 1 Dense ¹⁴		1750	120	455	1550		
No. 1		1500	120	390	1350		
No. 2 Dense ¹⁴		1400	105	455	1050		
No. 2		1200	105	390	900		
Dense Structural 86 ¹⁴	3" and 4" thick	2900	150	455	2200		
Dense Structural 72 ¹⁴		2350	135	455	1800		
Dense Structural 65 ¹⁴		2050	120	455	1600		
Dense Structural 58 ¹⁴		1750	105	455	1450		
No. 1 Dense SR ¹⁴		1750	120	455	1750	(All) 1,600,000	U.B.C. Standard No. 25-6-64
No. 1 SR		1500	120	390	1500		
No. 2 Dense SR ¹⁴		1400	105	455	1050		
No. 2 SR		1200	105	390	900		
Dense Structural 86 ¹⁴	5" thick and up	2400 ¹²	150	455	1800		
Dense Structural 72 ¹⁴		2000 ¹²	135	455	1550		
Dense Structural 65 ¹⁴		1800 ¹²	120	455	1400		
Dense Structural 58 ¹⁴		1600 ¹²	105	455	1300		
No. 1 Dense SR ¹⁴		1600 ¹²	120	455	1500		
No. 1 SR		1400 ¹²	120	390	1300		
No. 2 Dense SR ¹⁴		1400 ¹²	105	455	1050		
No. 2 SR		1200 ¹²	105	390	900		

TABLE NO. 25-A—ALLOWABLE UNIT STRESSES FOR STRESS-GRADE LUMBER (Continued)

SPECIES AND COMMERCIAL GRADE		ALLOWABLE UNIT STRESSES, POUNDS PER SQUARE INCH					RULES UNDER WHICH GRADED
		Extreme Fiber in Bending (and Tension Parallel to Grain)	Maximum Horizontal Shear	Compression Perpendicular to Grain	Compression Parallel to Grain	Modulus of Elasticity	
	SYMBDL†	<i>f</i> (or <i>f'</i>)	<i>H</i>	<i>q</i>	<i>c</i>	<i>E</i> ^a	
PINE, SOUTHERN ¹¹							
Industrial 86 KD ¹³	1", 1 1/4" and	2600	165	390	1950	(All) 1,600,000	U.B.C. Standard No. 25-6-64
Industrial 72 KD ¹³	1 1/2" thick	2200	150	390	1650		
Industrial 65 KD ¹³		2000	135	390	1550		
Industrial 58 KD ¹³		1750	120	390	1400		
Industrial 50 KD ¹³		1500	120	390	1100		
Industrial 86	1", 1 1/4" and	2500	150	390	1900		
Industrial 72	1 1/2" thick	2000	135	390	1550		
Industrial 65		1750	120	390	1350		
Industrial 58		1500	105	390	1250		
Industrial 50		1200	105	390	900		
SPRUCE, EASTERN							
1450f.-Structural Grade	J. & P. ¹⁵	1450	110	300	1050	(All) 1,200,000	U.B.C. Standard No. 25-8-64
1300f.-Structural Grade	J. & P. ¹⁵	1300	95	300	975		
1200f.-Structural Grade	J. & P. ¹⁵	1200	95	300	900		
REDWOOD							
Dense Structural	J. & P. ¹⁵ -B. & S. ¹⁵	1700	110	320	1450	(All) 1,200,000	U.B.C. Standard No. 25-7-64
Heart Structural	J. & P. ¹⁵ -B. & S. ¹⁵	1300	95	320	1100		
Dense Structural	P. & T.	—	—	320	1450		
Heart Structural	P. & T.	—	—	320	1100		

EXPLANATORY NOTES—TABLE NO. 25-A

¹In tension members the slope of grain limitations applicable to the middle portion of the length of the joist and plank and beam and stringer grades used shall apply throughout the length of the piece. For exception see footnote No. 11.

²Value applies to pieces used as planks.

³Value applies to two-inch (2") thick pieces of Select Structural Grade used as joists.

⁴For two-inch (2") thick pieces of Construction and Standard Grades used as joists:

H = 120 when length of split is approximately equal to one-half the width of piece.

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

H = 70 when length of split is approximately equal to one and one-half times width of piece.

⁵For three-inch (3") thick pieces of Select Structural, Construction and Standard Grades used as joists:

H = 120 when length of split is approximately two and one-fourth inches (2¼").

H = 80 when length of split is approximately four and one-half inches (4½"), and

⁶For four-inch (4") thick pieces of Select Structural, Construction and Standard Grades used as joists:

H = 120 when length of split is approximately three inches (3").

H = 80 when length of split is approximately six inches (6").

⁷The value of "E" may be increased 10 per cent where the lumber is surface seasoned before being fully loaded.

⁸For Beams and Stringers and for Posts and Timbers:

H = 120 when length of split is equal to one-half the nominal narrow face dimension.

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

H = 80 when length of split is equal to one and one-half times the nominal narrow face dimension.

NOTE: Values for lengths of split other than those given in Notes 4, 5 and 7 are proportionate.

⁹For two-inch (2") thick pieces of Construction and Standard Grades used as joists:

H = 100 when length of split is approximately equal to one-half the width of piece.

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

H = 60 when length of split is approximately equal to one and one-half times width of piece.

¹⁰For three-inch (3") thick pieces of Select Structural, Construction and Standard Grades used as joists:

H = 100 when length of split is approximately two and one-fourth inches ($2\frac{1}{4}$ ").

H = 70 when length of split is approximately four and one-half inches ($4\frac{1}{2}$ ") and

For four-inch (4") thick pieces of Select Structural, Construction and Standard Grades used as joists:

H = 100 when length of split is approximately three inches (3").

H = 70 when length of split is approximately six inches (6").

For Beams and Stringers and for Posts and Timbers:

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

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

H = 70 when length of split is equal to one and one-half times the nominal narrow face dimension.

NOTE: Values for lengths of splits other than those given in Notes 8, 9 and 10 are proportionate.

"All stress-grades under U.B.C. Standard No. 25-6-64 are all-purpose grades and apply to all sizes. Pieces so graded may be cut to shorter lengths without impairment of the stress rating of the shorter pieces.

Grade restrictions provided by U.B.C. Standard No. 25-6-64 apply to the entire length of the piece, and each piece is suitable for use in continuous spans, over double spans, or under concentrated loads without regrading for special shear or other special stress requirements.

The following variations apply to the provisions of U.B.C. Standard No. 25-6-64 for lumber in service under wet conditions or where the moisture content is

at or above fiber saturation point, as when continuously submerged: (a) the allowable unit stresses in bending, tension parallel to grain and horizontal shear shall be limited in all thicknesses to the stresses indicated for thicknesses of five inches (5") and up; (b) the allowable unit stresses for compression parallel to grain shall be limited to the stresses indicated for thicknesses of five inches (5") and up reduced by 10 per cent; (c) the allowable unit stresses for compression perpendicular to grain shall be reduced one-third.

¹⁰These stresses apply for loading either on narrow face or on wide face, which is an exception to U.B.C. Standard No. 25-6-64.

¹¹KD = Kiln dried in accordance with the provisions of U.B.C. Standard No. 25-6-64.

¹²Longleaf may be specified by substituting "Longleaf" for "Dense" in the grade name, and when so specified the same allowable stresses shall apply.

¹³The allowable unit stresses for tension parallel to grain "t" and compression parallel to grain "c" are applicable when the following additional provisions are applied to the grades:

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

¹⁴These grades applicable to two-inch (2") thickness only.

¹⁵Working stresses for Douglas Fir (Western Pine Region) shall be adjusted in accordance with basic stresses as set forth in U.B.C. Standard No. 25-1-64.

TABLE NO. 25-B—ALLOWABLE UNIT STRESSES FOR PLYWOOD (DOUGLAS FIR AND WESTERN LARCH)¹

TYPE OF STRESS	EXTERIOR A-A	EXTERIOR A-B EXTERIOR A-C	EXTERIOR CONCRETE FORM B-B; EXTERIOR B-C; EXTERIOR C-C; INTERIOR CONCRETE FORM B-B; INTERIOR SHEATHING C-D; AND C-D PLUGGED INTERIOR SHEATHING C-D (EXTERIOR GLUE)	ALL OTHER GRADES CONFORMING TO U.B.C. STANDARD NO. 25-9-64 ² APPLY THE FOLLOWING PERCENTAGES TO STRESSES FOR CORRESPONDING EXTERIOR GRADE
EXTREME FIBER in bending: Face grain // to span Face grain $\perp$ to span	2188 1875	2000 1875	1875 1875	100 65
TENSION // to face grain (3-ply only) ³ $\perp$ to face grain $\pm 45^\circ$ to face grain	2188 1875 337	2000 1875 320	1875 1875 310	100 ⁴ 65 75
COMPRESSION // to face grain (3-ply only) ³ $\perp$ to face grain $\pm 45^\circ$ to face grain	1605 1375 496	1460 1375 472	1375 1375 460	100 ⁴ 60 70
BEARING (on face)	405	405	405	100
SHEAR rolling in plane of plies ⁵ : // or $\perp$ to face grain $\pm 45^\circ$ to face grain	79 105	72 96	68 90	75 75

TABLE NO. 25-B—Continued

TYPE OF STRESS	EXTERIOR A-A	EXTERIOR A-B EXTERIOR A-C	EXTERIOR CONCRETE FORM B-B; EXTERIOR B-C; EXTERIOR C-C; INTERIOR CONCRETE FORM B-B; INTERIOR SHEATHING C-B; AND C-D PLUGGED INTERIOR SHEATHING C-D (EXTERIOR GLUE)	ALL OTHER GRADES CONFORMING TO U.B.C. STANDARD NO. 25-B-64; APPLY THE FOLLOWING PERCENTAGES TO STRESSES FOR CORRESPONDING EXTERIOR GRADE
SHEAR in plane $\perp$ to plies: // or $\perp$ to face grain $\pm 45^\circ$ to face grain	260 520	240 480	225 450	80 80
MODULUS OF ELASTICITY in bending: Face grain // to span Face grain $\perp$ to span	1,600,000 1,600,000	1,600,000 1,600,000	1,600,000 1,600,000	100 60
WET OR DAMP LOCATION				
Where moisture content will exceed 16 per cent, decrease by 20 per cent values shown for Dry Location for following properties: Extreme fiber in bending, tension and compression both parallel and perpendicular to grain and at 45 degrees, and bearing. (No change in values for shear or modulus of elasticity.) Only Exterior Type plywood should be used where moisture content will exceed 18 per cent.				

¹In bending, tension, and compression (except bearing and 45-degree stresses) consider only those plies with their grain direction parallel to the principal stress.

²With Douglas fir or Western larch faces and backs, and inner plies of any Western softwood species listed in Groups I, II, or III of U.B.C. Standard No. 25-9-64.

³For tension or compression, // to grain, in five-ply or thicker, use values for three-ply, but in next lower grade.

⁴For five or more plies use 80 per cent.

⁵The working stresses for rolling shear in glued joints shall be reduced by 50 per cent for flange web joints of beams having plywood webs, plywood gusset, plates and framing members located at the edges of stressed-skin plywood panels.

TABLE NO. 25-C—ALLOWABLE UNIT STRESSES FOR PLYWOOD,
WESTERN SOFTWOOD, GROUPS I AND II SPECIES ONLY¹

DRY LOCATION			
TYPE OF STRESS	EXTERIOR A1-A1, A-A INTERIOR A1-A1, A-A	EXTERIOR A1-C, A-B, A-C INTERIOR A1-D, A-B, A-D	EXTERIOR B-B, B-C, C-C INTERIOR B-B, B-D AND INTERIOR C-D
EXTREME FIBER in bending: Face grain // to span Face grain $\perp$ to span	1600 1350	1450 1350	1350 1350
TENSION // to face grain (3-ply only ²): $\perp$ to face grain $\pm 45^\circ$ to face grain	1600 1350 250	1450 1350 240	1350 1350 230
COMPRESSION // to face grain (3-ply only ²): $\perp$ to face grain $\pm 45^\circ$ to face grain	1000 900 320	950 900 300	900 900 290
BEARING (on face)	310	310	310
SHEAR, rolling, in plane of plies ³ : // or $\perp$ to face grain $\pm 45^\circ$	60 80	55 75	50 70
SHEAR, in plane $\perp$ to plies: // or $\perp$ to face grain $\pm 45^\circ$	200 400	185 370	170 340
MODULUS OF ELASTICITY in bending: Face grain // or $\perp$ to span: Group I Group II	1,300,000 1,100,000	1,300,000 1,100,000	1,300,000 1,100,000
WET OR DAMP LOCATION			
Where moisture content will exceed 16 per cent, decrease by 20 per cent values shown for dry location for following properties: Extreme fiber in bending, tension and compression both parallel and perpendicular to the grain and at 45 degrees, and bearing. (No change in values for rolling shear or modulus of elasticity. Reduce shear in plane perpendicular to plies by 13 per cent.)			

¹For grades, thicknesses and species of Western softwood plywood listed in U.B.C. Standard No. 25-9-64.²For tension or compression parallel to grain in five-ply or thicker, use values for three-ply, but in next lower grade.³The working stresses for rolling shear in glued joints shall be reduced by 50 per cent for flange web joints of beams having plywood webs, plywood gusset plates and framing members located at the edges of stressed-skin plywood panels.

TABLE NO. 25-D—ALLOWABLE UNIT STRESSES—STRUCTURAL GLUED-LAMINATED LARCH, SOUTHERN PINE AND WEST COAST HEMLOCK LUMBER—DRY CONDITIONS OF USE

Allowable unit stresses are for normal conditions of loading, pounds per square inch.

COMBINATION NUMBER	SPECIES AND COMMERCIAL GRADE COMBINATION			EXTREME FIBER IN BENDING "f"		TENSION PARALLEL TO GRAIN "t"		COMPRESSION PARALLEL TO GRAIN "c"		HORIZONTAL SHEAR "H" 10	COMPRESSION PERPENDICULAR TO GRAIN "q" 11
	1	2	3	4	5	6	7	8	9		
	Grade of Laminations at Top and Bottom	Number at Top and Bottom	Grade of Inner Laminations	From 4 to 14 Laminations	15 or More Laminations	From 4 to 14 Laminations	15 or More Laminations	From 4 to 14 Laminations	15 or More Laminations		
LARCH—2" Thickness											
LD-1	C Select	All	C Select	2600	2600	2600	2600	2200	2200	165	385
LD-2	C Select	Two	No. 1 or No. 2 Dim.	2600	2600	2600	2600	2100	2100	165	385
LD-3	C Select	One	No. 1 or No. 2 Dim.	2300	2300	2600	2600	2100	2100	165	385
LD-4	Structural	All	Structural	2000	2200	2600	2600	2100	2100	165	385
LD-5	Structural	One	No. 1 or No. 2 Dim.	1900	2000	2600	2600	2000	2000	165	385
LD-6	No. 1 or No. 2 Dim.	All	No. 1 or No. 2 Dim.	1400	1800	2600	2600	2000	2000	165	385
LARCH—1" Thickness											
LD-11	C Select	All	C Select	2600	2600	2600	2600	2200	2200	165	385
LD-12	C Select	One	No. 2 & Better Common	2600	2600	2600	2600	2100	2100	165	385
LD-13	C Select	One	No. 3 Common	2500	2500	2600	2600	2100	2100	165	385
LD-14	No. 2 & Better Common	All	No. 2 & Better Common	2400	2400	2600	2600	2100	2100	165	385
LD-15	No. 2 & Better Common	One	No. 3 Common	2300	2300	2600	2600	2000	2000	165	385
LD-16	No. 3 Common	All	No. 3 Common	2000	2100	2600	2600	2000	2000	165	385

**TABLE NO. 25-D—ALLOWABLE UNIT STRESSES—STRUCTURAL GLUED-LAMINATED LARCH, SOUTHERN PINE AND WEST COAST HEMLOCK
LUMBER—DRY CONDITIONS OF USE—Continued**

Allowable unit stresses are for normal conditions of loading, pounds per square inch.

COMBINATION NUMBER	SPECIES AND COMMERCIAL GRADE COMBINATION			EXTREME FIBER IN BENDING "f"		TENSION PARALLEL TO GRAIN "t"		COMPRESSION PARALLEL TO GRAIN "c"		HORIZONTAL SHEAR "H" 10	COMPRESSION PERPENDICULAR TO GRAIN "q" 11
	1	2	3	4	5	6	7	8	9		
	Grade of Laminations at Top and Bottom	Number at Top and Bottom	Grade of Inner Laminations	From 4 to 14 Laminations	15 or More Laminations	From 4 to 14 Laminations	15 or More Laminations	From 4 to 14 Laminations	15 or More Laminations		
SOUTHERN PINE											
1	No. 1 Dense	All	No. 1 Dense	3000	3000	3000	3000	2400	2500	200	450
2	B&B Dense	One	No. 1	3000	3000	2600	2600	2100	2100	200	450
3	No. 1 Dense	1/14 of total	No. 1	3000	3000	2600	2600	2100	2100	200	450
4	B&B Dense	One	No. 2 Dense	2800	2800	3000	3000	2400	2400	200	450
5	No. 1 Dense	1/5 of total	No. 2 Dense	2800	3000	2800	3000	2300	2400	200	450
6	No. 1	All	No. 1	2600	2600	2600	2600	2100	2100	200	385
7	B&B Dense	1/14 of total	No. 2	2400	2800	2600	2600	2000	2000	200	450
8	B&B	One	No. 2	2400	2400	2600	2600	2000	2000	200	385
9	No. 1	1/5 of total	No. 2	2400	2600	2400	2600	2000	2000	200	385
10	No. 2 Dense	All	No. 2 Dense	2000	2600	2600	3000	2200	2300	200	450
11	No. 2 Dense	1/14 of total	No. 2	2000	2600	2200	2600	1900	2000	200	450
12	No. 2	All	No. 2	1800	2200	2200	2600	1900	2000	200	385
13	No. 1	1/5 of total	No. 3 ¹	1800 ²	2400	2400 ²	2500	1900 ²	2000	200	385
14	No. 2	1/5 of total	No. 3 ¹	1800 ²	2200	2200 ²	2300	1900 ²	1900	200	385

¹Pitch, pitch pockets, pitch streaks, red heart, wane, shakes and decay in No. 3 Southern Pine boards and dimension used for structural gluing shall not exceed that permitted in No. 2 dimension.

²Must have not less than six laminations.

TABLE NO. 25-D—ALLOWABLE UNIT STRESSES—STRUCTURAL GLUED-LAMINATED LARCH, SOUTHERN PINE AND WEST COAST HEMLOCK LUMBER—DRY CONDITIONS OF USE—Continued
 Allowable unit stresses are for normal conditions of loading, pounds per square inch.

COMBINATION NUMBER	SPECIES AND COMMERCIAL GRADE COMBINATION			EXTREME FIBER IN BENDING "f"		TENSION PARALLEL TO GRAIN "t"		COMPRESSION PARALLEL TO GRAIN "c"		HORIZONTAL SHEAR "H" 10	COMPRESSION PERPENDICULAR TO GRAIN "q" 11
	1	2	3	4	5	6	7	8	9		
	Grade of Laminations at Top and Bottom	Number at Top and Bottom	Grade of Inner Laminations	From 4 to 14 Laminations	15 or More Laminations	From 4 to 14 Laminations	15 or More Laminations	From 4 to 14 Laminations	15 or More Laminations		
WEST COAST HEMLOCK											
1	Clear	One	Select	2200	2200	2200	2200	1700	1700	140	365
2	Clear	One	Structural	2200	2200	2200	2200	1600	1700	140	365
3	Select	All	Select	2200	2200	2200	2200	1700	1700	140	365
4	Structural	One	Structural	2000	2200	2000	2200	1600	1700	140	365
5	Select	Two	Construction	2000	2200	2200	2200	1700	1700	140	365
6	Structural	Two	Standard	2000	2200	2200	2200	1600	1600	140	365
7	Construction	All	Construction	1800	2000	2000	2200	1600	1700	140	365
8	Clear	One	Standard	2000	2000	1800	2000	1500	1600	140	365
9	Select										
10	Structural	One	Standard	2000	2000	1800	2000	1500	1600	140	365
11	Construction	One	Standard	1800	2000	1800	2000	1500	1600	140	365
	Standard	All	Standard	1600	1800	1800	2000	1500	1600	140	365

NOTES: Modulus of elasticity, "E," dry conditions of use for larch and Southern pine, 1,800,000; for West Coast Hemlock, 1,540,000.

Allowable stress values for dry conditions of use shall be applicable for normal loading when the moisture content in service is less than 16 per cent as in most covered structures.

For wet conditions of use, the following maximum percentages of Dry Use Stresses shall be permitted:

"f" (bending) and "t" (tension) 80 per cent.

"H" (horizontal shear) and "M" (modulus of elasticity) 90 per cent.

"c" and "q" (compression parallel and perpendicular) 70 per cent.

TABLE NO. 25-E—STRUCTURAL GLUED-LAMINATED DOUGLAS FIR (COAST REGION) TIMBER

PART A—MEMBERS STRESSED PRINCIPALLY IN BENDING—LOADED PERPENDICULAR TO WIDE FACE OF LAMINATIONS							
DRY CONDITIONS OF USE							
COMBINATION	EXTREME FIBER IN BENDING "f"	TENSION PARALLEL TO GRAIN		COMPRESSION PARALLEL TO GRAIN		HORIZONTAL SHEAR "H"	COMPRESSION PERPENDICULAR TO GRAIN "c $\perp$ "
		"t"	"t" Special ²	"c"	"c" Special ²		
A	2600	1600	2200	1500	1900	165	450
B	2400	1600	2000	1500	1800	165	450
C	2200	1600	1800	1500	1800	165	450
Modulus of Elasticity "E" Dry Conditions of Use, 1,800,000.							
WET CONDITIONS OF USE ¹							
A	2000	1300	1800	1100	1400	145	305
B	1800	1300	1600	1100	1300	145	305
C	1600	1300	1400	1100	1300	145	305

Modulus of Elasticity "E" Wet Conditions of Use, 1,600,000.

¹Allowable unit stresses for normal conditions of loading. Pounds per square inch.

²For the Special values for tension parallel to grain, "t," and for compression parallel to grain, "c," the slope of grain of all laminations in the member must not be steeper than that required in the outer 10 per cent of laminations.

**PART B—MEMBERS STRESSED PRINCIPALLY IN AXIAL COMPRESSION, AXIAL TENSION, OR
LOADED PARALLEL OR PERPENDICULAR TO WIDE FACE OF LAMINATIONS**

DRY CONDITIONS OF USE¹

COMBINATION	COMPRESSION PARALLEL TO GRAIN "C"	TENSION PARALLEL TO GRAIN "F" AND EXTREME FIBER IN BENDING "F" WHEN LOADED PARALLEL OR PERPENDICULAR TO WIDE FACE OF LAMINATIONS	HORIZONTAL SHEAR "H"		COMPRESSION PERPENDICULAR TO GRAIN "C ⊥"
			Loaded Perpendicular to Wide Face of Laminations	Loaded Parallel to Wide Face of Laminations	
E	2200	2600	165	145	450
F	2100	2200	165	145	450
G	1800	1800	165	145	385
H	1500	1200	165	145	385

Modulus of Elasticity "E" Dry Conditions of Use, 1,800,000.

WET CONDITIONS OF USE¹

E	1600	2000	145	120	305
F	1500	1800	145	120	305
G	1300	1400	145	120	260
H	1100	950	145	120	260

Modulus of Elasticity "E" Wet Conditions of Use, 1,600,000.

¹Allowable unit stresses for normal conditions of loading. Pounds per square inch.

TABLE NO. 25-E (Continued)
PART C—GRADE REQUIREMENTS FOR THE TABULATED ALLOWABLE UNIT STRESSES

COMBINATION	NUMBER OF LAMINATIONS	MINIMUM GRADE OF LAMINATIONS					SLOPE OF GRAIN	
		Top and Bottom Zone		Intermediate Zone		Inner Zone		
		Grade	Number	Grade	Number	Grade	Outer 10 per Cent of Laminations	Next Inner 10 per Cent of Laminations
A	4 to 8 9 to 20 21 or more	L 1	2	L 3	—	L 3	1:14	1:12
		L 1	2	L 2	2	L 3		
		L 1	3	L 2	2	L 3		
B	4 to 8 9 or more	L 1	1	L 2	1	L 3	1:12	1:10
		L 1	1	L 2-D	2	L 3		
C	4 or more	L 2-D	2	L 3	—	L 3	1:12	1:10
E	All			L 1			1:14 All	
F	All			L 2-D			1:12 All	
G	All			L 2			1:12 All	
H	All			L 3			1:8 All	

TABLE NO. 25-F—PART A—ALLOWABLE UNIT STRESSES FOR GLUED HARDWOOD LAMINATED LUMBER¹ FOR NORMAL LOADING DURATION—
DRY CONDITION OF USE²

SPECIES	MULTIPLY THE APPROPRIATE STRESS MODULE IN PART B BY THE FACTORS BELOW TO DETERMINE ALLOWABLE STRESS FOR		ALLOWABLE UNIT STRESS (Pounds per Square Inch)		
	Extreme Fiber in Bending "f" or Tension Parallel to Grain "t"	Compression Parallel to Grain "c"	Horizontal Shear "H"	Compression Perpendicular to Grain "q"	Modulus of Elasticity "E"
Hickory, true and pecan	3.90	3.05	260	730	2,000,000
Beech, American	3.05	2.45	230	610	1,800,000
Birch, sweet and yellow	3.05	2.45	230	610	1,800,000
Elm, rock	3.05	2.45	230	610	1,400,000
Maple, black and sugar (hard maple)	3.05	2.45	230	610	1,800,000
Ash, commercial white	2.85	2.20	230	610	1,600,000
Oak, commercial red and white	2.85	2.05	230	610	1,600,000
Elm, American and slippery (white or soft elm)	2.20	1.60	190	310	1,300,000
Sweet gum (red or sap gum)	2.20	1.60	190	370	1,300,000
Tupelo, black (black gum)	2.20	1.60	190	370	1,300,000
Tupelo, water	2.20	1.60	190	370	1,300,000
Ash, black	2.00	1.30	170	370	1,200,000
Poplar, yellow	1.80	1.45	150	270	1,200,000
Cottonwood, Eastern	1.55	1.20	110	180	1,100,000

TABLE NO. 25-F

TABLE NO. 25-F—PART B—VALUES FOR USE IN COMPUTING WORKING STRESSES WITH FACTORS OF PART A TOGETHER WITH LIMITATIONS REQUIRED TO PERMIT THE USE OF SUCH STRESSES²

RATIO OF SIZE OF MAXIMUM PERMITTED KNOT TO FINISHED WIDTH OF LAMINATION ¹	NUMBER OF LAMINATIONS	EXTREME FIBER IN BENDING			TENSION PARALLEL TO GRAIN			COMPRESSION PARALLEL TO GRAIN	
		Stress Module	Steepest Grain Slope	Steepest Scarf Slope	Stress Module	Steepest Grain Slope	Steepest Scarf Slope	Stress Module	Steepest Grain Slope
0.1	4 to 14	800	1:16	1:10	800	1:16	1:10	970	1:15
.1	15 or more	800	1:16	1:10	800	1:16	1:10	980	1:15
.2	4 to 14	800	1:16	1:10	800	1:16	1:10	930	1:15
.2	15 or more	800	1:16	1:10	800	1:16	1:10	950	1:15
.3	4 to 14	670	1:12	1:8	800	1:16	1:10	870	1:15
.3	15 or more	770	1:16	1:10	800	1:16	1:10	900	1:15
.4	4 to 14	520	1:8	1:5	640	1:12	1:8	810	1:12
.4	15 or more	660	1:12	1:8	750	1:15	1:8	860	1:14
.5	4 to 14	390	1:8	1:5	480	1:8	1:5	730	1:10
.5	15 or more	550	1:10	1:15	630	1:12	1:8	800	1:12

¹The allowable unit stresses in bending obtained from Table No. 25-F apply when the wide faces of the lamination are normal to the direction of the load.

²Allowable stresses for dry conditions of use shall be applicable when the moisture content in service is 15 per cent or less as in most covered structures. For wet conditions of use the following maximum percentage of the dry use stresses shall be permitted:

"f" (bending) and "t" (tension) 80 per cent

"H" (horizontal shear) and "E" (modulus of elasticity) 90 per cent

"c" (compression parallel to grain) 70 per cent

"q" (compression perpendicular to grain) 67 per cent

³For modification of allowable unit stresses for structural glued-laminated lumber see Section 2504.

⁴Factors for knot sizes of 0.1 and 0.2 are identical in case of extreme fiber in bending and in tension parallel to grain because a slope of grain of 1:16 is a greater limitation than knot size. The smaller knot size may be specified for reasons other than strength.

Stresses for grades and species other than those tabulated shall be established by the Building Official; for sawn lumber when determined in accordance with U.B.C. Standard No. 25-1-64; and for species and grade combinations used in structural glued laminated lumber when determined in accordance with U.B.C. Standard No. 25-10-64.

Allowable unit stresses of plywood other than as provided in Tables No. 25-B and No. 25-C shall be determined according to species.

2. **Stresses in poles or piles used as structural members.** Induced stresses in pounds per square inch for normal loading of round poles or piles when used as structural members, except modulus of elasticity which shall be the same as for sawn lumber, shall not exceed 60 per cent of the basic unit working stresses for clear lumber for the species as set forth in U.B.C. Standard No. 25-1-64, and the pieces shall meet the requirements of U.B.C. Standard No. 25-13-64 for poles or U.B.C. Standard No. 25-14-64 for piles.

(c) **Identification.** All species set forth in Tables No. 25-A and No. 25-G shall be used only when identified by a grade mark of, or certificate of inspection issued by, an approved grading or inspection bureau or agency.

All plywood when used structurally, including, among others, use for siding, roof and wall sheathing, subflooring, diaphragms, and built-up beams, shall conform to performance standards for its type as set forth in U.B.C. Standard No. 25-9-64; it shall be identified as to species grade and glue type by an approved agency. In addition to the above requirements all plywood when permanently exposed in outdoor applications shall be of exterior type.

The allowable unit stresses for structural glued-laminated lumber as set forth in U.B.C. Standard No. 25-10-64 and in Tables No. 25-D, No. 25-E and No. 25-F shall be used only when the material and workmanship are in accordance with U.B.C. Standard No. 25-10-64 or No. 25-11-64, respectively, and are inspected and identified in a manner meeting the approval of the Building Official.

(d) **Conditions of Service.** The allowable unit stresses as set forth in Table No. 25-A and adjustments thereof apply to lumber used under conditions continuously dry, such as in most covered structures. Under such conditions of use the modulus of elasticity may be increased 10 per cent for lumber that is surface seasoned before loading to the maximum allowable load. Except for compression parallel and compression perpendicular to the grain, they also apply to lumber used under conditions where the moisture content of the wood is permanently at or above the fiber saturation point, as when continuously submerged.

When used under continuously wet conditions, the allowable unit stresses as set forth in Table No. 25-A for compres-

**Allowable
Unit
Stresses
(Continued)**

**Allowable
Unit
Stresses
(Continued)**

sion parallel to grain shall be reduced 10 per cent and for compression perpendicular to grain shall be reduced one-third.

The allowable unit stresses as set forth in Tables No. 25-A, No. 25-D, No. 25-E and No. 25-F and adjustments thereof, and stresses as set forth in Tables No. 25-B and No. 25-C apply also to lumber, to structural glued-laminated lumber and to exterior type plywood that has been pressure-impregnated by an approved process and to the heartwood of durable species under dry or other conditions of use.

The allowable unit stresses for structural glued-laminated lumber as set forth in Tables No. 25-D, No. 25-E and No. 25-F shall be for dry conditions of use where the moisture content in service is 16 per cent or less, as in most covered structures. For wet conditions of use, the maximum percentage of the dry-use stress permitted shall be as specified in the footnotes applicable to the respective tables.

(e) **Adjustment of Allowable Unit Stresses for Duration of Load.** The allowable unit stresses as set forth in Table No. 25-A for sawn lumber and Tables No. 25-D, No. 25-E and No. 25-F for structural glued-laminated lumber, and the values for mechanical fastenings as hereinafter established, shall be applicable as follows for the various durations of loading:

1. Where a member is fully stressed to the maximum allowable stress, either continuously or cumulatively for more than 10 years under the condition of maximum design load, the allowable unit stresses used in the design shall not exceed 90 per cent of those in the tables.

2. When the duration of the full maximum load does not exceed the period indicated below, the allowable unit stresses shall be increased in the tables as follows:

- 15 per cent for two months duration, as for snow
- 25 per cent for seven days duration
- 33 1/3 per cent for wind or earthquake
- 100 per cent for impact

Allowable unit stresses given in the tables for normal loading conditions may be used without regard to impact if the stress induced by impact does not exceed the allowable unit stress for normal loading.

The above increases are not cumulative. For combined durations of loading, the resulting structural members shall not be smaller than required for a longer duration of loading.

(f) **Horizontal Shear Adjustment.** The unit stress in horizontal shear in members of rectangular section stressed in flexure shall be computed by use of the following formula:

$$H = \frac{3R}{2bh}$$

WHERE:

R = reaction, pounds, under the following conditions:

- (1) Distribution of load to adjacent beams through flooring or other members shall be considered.
- (2) All loads uniform or concentrated, within a distance of the height of the beam from the nearest support, shall be neglected.
- (3) All concentrated loads located at a distance from the support of one to three times the height of the beam shall be considered as placed at three times the height of the beam from the support.

(g) **Adjustments of Allowable Unit Stresses for Joint Details.** 1. **Compression.** In joists supported on a ribbon or ledger board and spiked to the studding, the allowable stress in compression perpendicular to grain may be increased 50 per cent.

Allowable unit stresses in compression perpendicular to grain as set forth in Table No. 25-A shall be increased in accordance with the following factors for bearing less than six inches (6") in length and located three inches (3") or more from the end of a timber.

Length of bearing (inches)	½	1	1½	2	3	4	6 or more
Factor	1.75	1.38	1.25	1.19	1.13	1.10	1.00

For stress under washers or small plates the same factor may be taken as for a bearing, the length of which equals the diameter of the washer.

2. **Shear.** Allowable unit stresses in shear for joint details shall be 150 per cent of the horizontal shear values as set forth in Tables No. 25-A, No. 25-D, No. 25-E, and No. 25-F.

In computing the horizontal shear in eccentric joints the effective depth of the member shall be assumed as its actual depth less the distance from the unloaded edge to the nearest edge of the nearest connector. Where bolts alone are used, the distance from the unloaded edge to the center of the nearest bolt shall be subtracted.

(h) **Holes and Notches.** Girders, beams, or joists may be notched or bored in any part of the section within three times the beam depth from either support. Such notches or holes shall not exceed one-fifth of the depth of beam except at point of support and as hereinafter provided.

Where girders, beams, or joists are notched at points of support, they shall meet design requirements for net section in bending and in shear. The shear at such point shall not exceed the value calculated by the following formula:

$$V = \frac{2}{3} \left(\frac{bd^2 H}{h} \right)$$

**Allowable
Unit
Stresses
(Continued)**

WHERE:

d = actual depth of beam at the notch

h = total depth of beam.

Where notches or holes are made in other portions of the beam, the net remaining depth of beam shall be used in determining the bending strength.

(i) **Compression on Inclined Surfaces.** The unit stress (compression) normal to a plane inclined to the fiber of a wood member shall not exceed that determined from the formula:

$$N = \frac{c q}{c \sin^2 \theta + q \cos^2 \theta}$$

Columns

Sec. 2505. (a) General. Columns, posts, struts, and other members in compression parallel to grain shall be designed structurally as provided in this Section.

(b) **Solid Columns.** Simple solid wood columns consist of a single piece of sawn lumber or structurally glued-laminated lumber.

The safe load in pounds per square inch of net cross-sectional area, for simple columns or other solid members stressed in compression parallel to grain, shall be determined by the following formula, but the maximum unit load " P/A " shall not exceed the values for compression parallel to grain " c " in Tables No. 25-A, No. 25-D, No. 25-E, and No. 25-F adjusted in accordance with the provisions of Subsection 2504 (e):

$$P/A = \frac{3.619E}{(l/r)^2}$$

For columns of square or rectangular section the following formula shall be used:

$$P/A = \frac{0.30E}{(l/d)^2}$$

WHERE:

d = least dimension of square or rectangular columns, in inches

l = unsupported length in inches

r = least radius of gyration of the section

Columns shall be limited in maximum length between points of lateral support to $l = 50d$, except that the individual members of spaced columns shall be limited in maximum length to $l = 80d$.

(c) **Spaced Columns.** Spaced columns or compression members shall be based upon design principles acceptable to the Building Official, or the design principles set forth for spaced columns in U.B.C. Standard No. 25-15-64.

(d) **Axial Loading.** The allowable axial unit stresses are subject to adjustment for duration of load and conditions of service as specified in Section 2504. **Columns (Continued)**

(e) **Combined Flexural and Axial Loading.** Members subjected to both flexural and axial loading shall be designed in accordance with the provisions set forth in U.B.C. Standard No. 25-16-64.

Sec. 2506. (a) Timber Connectors. Timber connectors may be used to transmit stress between wood members and between wood and metal members. The allowable loads and installation of timber connectors shall be as set forth in U.B.C. Standard No. 25-17-64. **Timber Connections and Fastenings**

Safe loads and design practices for types of connectors not mentioned or fully covered in U.B.C. Standard No. 25-17-64 may be determined in a manner approved by the Building Official.

(b) **Bolts.** Bolted joints wherein bolts are used to resist or transfer stresses in wood structures shall be designed in accordance with the provisions set forth in U.B.C. Standard No. 25-17-64. Safe loads in pounds for bolts in double shear and in seasoned lumber of the following species: Douglas fir (coast region) and Douglas fir; larch; pine, southern; in joints consisting of three members in which the side members are one-half the thickness of the main member, shall not exceed values set forth in Tables No. 25-H and No. 25-I. (For other species see U.B.C. Standard No. 25-17-64.)

(c) **Drift Bolts or Pins.** Connections of wood structural members involving the use of drift bolts or drift pins shall be designed in accordance with the provisions set forth in U.B.C. Standard No. 25-17-64.

TABLE NO. 25-G—GROUP CLASSIFICATION—NONSTRESS-GRADED LUMBER

SPECIES	MINIMUM GRADE	UNIFORM BUILDING CODE STANDARD NUMBER
GROUP I		
Douglas Fir (Coast Region) ¹	Construction	25-3-64
Douglas Fir ¹	Construction	25-4-64
Larch, Western ¹	Construction	25-4-64
Pine, Southern ¹	No. 3 MCKD	25-6-64
GROUP II		
Bald Cypress (Tidewater Red Cypress)	No. 2	25-2-64
Fir, White	Construction	{ 25-3-64
Hemlock, Eastern	No. 1	{ 25-4-64
Hemlock, West Coast ¹	Construction	25-5-64
		25-3-64

**Timber
Connections
and
Fastenings
(Continued)**

TABLE NO. 25-G (Continued)

SPECIES	MINIMUM GRADE	UNIFORM BUILDING CODE STANDARD NUMBER
Hemlock, Western ¹	Construction	25-4-64
Pine, Red (Norway Pine)	No. 1	25-5-64
Pine, Southern	Special	25-6-64
Redwood, California	Select Heart	25-7-64
Spruce, Eastern	No. 1	25-8-64
Spruce, Sitka	Construction	25-3-64
GROUP III		
Cedar, Western	Construction	25-3-64
Cedar, Western Red and Incense	Construction	25-4-64
Douglas Fir (Coast Region) ¹	Standard	25-3-64
Douglas Fir ¹	Standard	25-4-64
Fir, Balsam	No. 1	25-8-64
Fir, White	Standard	{25-3-64 25-4-64}
Hemlock, Eastern	No. 2	25-5-64
Hemlock, West Coast ¹	Standard	25-3-64
Hemlock, Western ¹	Standard	25-4-64
Larch, Western ¹	Standard	25-4-64
Pine, Ponderosa, Lodgepole, Sugar, Idaho White	Construction	25-4-64
Pine, Southern	No. 3 MGKD	25-6-64
Pine, Southern ¹	No. 3	25-6-64
Redwood, California	Sap Common	25-7-64
Redwood, California (studs only)	Two Star	25-7-64
Spruce, Engelmann	Construction	25-4-64
Spruce, Sitka	Standard	25-3-64
GROUP IV [See Section 2504 (b) para. 5]		
Cedar, Western	Utility	25-3-64
Cedar, Western Red and Incense	Utility	25-4-64
Douglas Fir (Coast Region)	Utility	25-3-64
Douglas Fir	Utility	25-4-64
Fir, White	Utility	{25-3-64 25-4-64}
Hemlock, West Coast	Utility	25-3-64
Hemlock, Western	Utility	25-4-64
Larch, Western	Utility	25-4-64
Pine, Ponderosa, Lodgepole, Sugar, Idaho White	Utility	25-4-64
Pine, Southern	No. 3	25-6-64
Redwood, California	Merchantable	25-7-64
Redwood, California (studs only)	One Star	25-7-64
Spruce, Engelmann	Utility	25-4-64
Spruce, Sitka	Utility	25-3-64

¹Two-inch by four-inch (2" x 4") only.

(d) **Wood Screws.** Connections involving the use of wood screws shall be designed in accordance with the provisions set forth in U.B.C. Standard No. 25-17-64.

(e) **Lag Screws.** Connections involving the use of lag screws shall be designed in accordance with the provisions set forth in U.B.C. Standard No. 25-17-64.

(f) **Nails and Spikes.** 1. **Safe lateral strength.** A common wire nail driven perpendicular to grain of the wood, when used to fasten wood members together, shall not be subjected to a greater load causing shear and bending than the safe lateral strength of the wire nail or spike as set forth in Table No. 25-J.

A wire nail driven parallel to the grain of the wood or toenailed shall not be subjected to more than two-thirds of the lateral load allowed when driven perpendicular to grain.

2. **Safe resistance to withdrawal.** A wire nail driven perpendicular to grain of the wood shall not be subjected to a greater load, tending to cause withdrawal, than the safe resistance of the nail to withdrawal, as set forth in Table No. 25-K.

Nails driven parallel to grain of the wood shall not be allowed for resisting withdrawal forces.

**Timber
Connections
and
Fastenings
(Continued)**

TABLE NO. 25-H—HOLDING POWER OF BOLTS
Loads Parallel to Grain (p)

LENGTH OF BOLT IN MAIN MEMBER ¹ (Inches)	DIAMETER OF BOLT (Inches)						
	½	¾	¾	¾	1	1½	1½
1 ¾	1010	1290	1550	1810	2070		
2 ¾	1280	1890	2430	2900	3340		
3 ¾	1290	2010	2860	3680	4430		
4 ½	1290	2010	2890	3920	4980	5980	
5 ½		2010	2890	3940	5120	6440	
6 ½		2010	2890	3940	5140	6500	
7 ½		2010	2890	3940	5140	6500	
9 ½			2890	3940	5140	6500	8040
11 ½					5140	6500	8040

¹This assumes dressed size lumber. Safe loads for other lengths of bolt in main member may be obtained by interpolation.

TABLE NO. 25-I—HOLDING POWER OF BOLTS
Loads Perpendicular to Grain (q)

LENGTH OF BOLT IN MAIN MEMBER ¹ (Inches)	DIAMETER OF BOLT (Inches)						
	½	¾	¾	¾	1	1½	1½
1 ¾	480	540	600	670	730		
2 ¾	780	880	980	1080	1170		
3 ¾	1020	1210	1350	1490	1620		
4 ½	1020	1440	1680	1840	2010	2190	
5 ½		1450	1940	2250	2460	2680	
6 ½		1390	1940	2510	2880	3170	
7 ½		1300	1880	2500	3130	3610	
9 ½			1690	2350	3050	3830	4590
11 ½					2850	3660	4490

¹This assumes dressed size lumber. Safe loads for other lengths of bolt in main member may be obtained by interpolation.

**Timber
Connections
and Fastenings
(Continued)**

3. **Spacing and penetration.** Common wire nails shall have penetration into the piece receiving the point as set forth in Table No. 25-J. Nails or spikes, for which the wire gauges or lengths are not specified in Table No. 25-J, shall have a required penetration of not less than 11 diameters, and allowable loads may be interpolated.

For wood to wood joints the spacing center-to-center shall be not less than the required penetration.

Edge and end distances shall be not less than one-half of the required penetration.

Holes for nails, where necessary to prevent splitting, shall be bored of a diameter smaller than that of the nails.

4. **Groups I and J Occupancies.** The number and size of nails connecting wood members of Groups I and J Occupancies shall be not less than the amount set forth in Table No. 25-L. Other connections shall be nailed to provide equivalent strength.

Plywood subflooring and roof sheathing shall be nailed at six inches (6") on center at panel edges and boundary members and twelve inches (12") on center at intermediate supports. The nails shall be of sufficient size to provide the minimum penetration required in Table No. 25-J. See Section 2511 for nailing of plywood required at vertical or horizontal diaphragm.

(g) **Joist Hangers and Framing Anchors.** Connections depending upon joist hangers or framing anchors, ties, and other mechanical fastenings not otherwise covered may be used where approved.

**Vertical
Members or
Assemblies**

Sec. 2507. (a) **Columns or Posts.** All wood columns and posts shall be framed to true end bearings; shall extend down

**TABLE NO. 25-J—SAFE LATERAL STRENGTH AND REQUIRED
PENETRATION OF COMMON WIRE NAILS'
DRIVEN PERPENDICULAR TO GRAIN OF WOOD**

SIZE OF NAIL	STANDARD LENGTH (Inches)	WIRE GAUGE	PENETRATION REQUIRED (Inches)	LOADS (Pounds)	
				Douglas Fir Larch or Southern Pine	Other Species
6d	2	11½	1¼	63	Sec U.B.C. Standard No. 25-17-64
8d	2½	10¼	1½	78	
10d	3	9	1¾	94	
12d	3¼	9	1⅝	94	
16d	3½	8	1¾	107	
20d	4	6	2⅜	139	
30d	4½	5	2¼	154	
40d	5	4	2½	176	
50d	5½	3	2¾	202	
60d	6	2	2¾	223	

'The lateral strength values of hot wire nails shall not exceed 75 per cent of the values for common wire nails. The safe lateral strength values may be increased 25 per cent where metal side plates are used.

**TABLE NO. 25-K—SAFE RESISTANCE TO WITHDRAWAL
OF COMMON WIRE NAILS**

Inserted Perpendicular to Grain of the Wood, in Pounds per Linear Inch
of Penetration into the Main Member

Vertical
Members or
Assemblies
(Continued)

KIND OF WOOD	SIZE OF NAIL									
	8d	8d	10d	12d	16d	20d	30d	40d	50d	60d
Douglas Fir, Larch or Southern Pine	33	39	44	44	48	57	61	67	72	78
Other Species	See U.B.C. Standard No. 25-17-64									

**TABLE NO. 25-L—NUMBER OF NAILS FOR CONNECTING
WOOD MEMBERS**

Groups I and J Occupancies

CONNECTION	BOX OR COMMON
Joist to sill or girder—toe nail	2-16d
Bridging to joist—toe nail	2- 8d
1 x 6 subfloor to joist—face nail	2- 8d
2-inch subfloor to joist or girder	2-16d
Plate to joist or blocking	16d-16" o.c.
Stud to plate—end nail	2-16d
Stud to plate—toenail	3-16d or 4-8d
Top plates—spike together	16d-24" o.c.
—laps and intersections	2-16d
Ceiling joists—to plate—toenail	2-16d
—laps over partitions	3-16d
—to parallel alternate rafters	3-16d
Rafter to plate	3-16d
Continuous 1-inch brace to stud	2- 8d
2-inch cut-in bracing to stud	2-16d
1-inch sheathing to bearing	2- 8d
Corner studs and angles	16d-30" o.c.
Plywood roof or floor sheathing	See Section 2506 (f) 4

to supports of such design as to hold the column or post securely in position and to protect its base from deterioration; and shall be supported in basements by piers projecting at least two inches (2") above the finished floor and separated therefrom by an approved metal barrier, or when pressure-impregnated timber is used, it may be placed directly on concrete or masonry.

Untreated wood columns in basements, when built into masonry partitions or walls, shall be exposed on at least two sides.

(b) **Stud Walls and Bearing Partitions.** 1. **Placing.** Studs in walls and partitions may be placed with their wide faces parallel to the wall or partition, provided the studs are considered as columns and are designed accordingly. Stud walls shall have top and bottom plates except that joists may be supported by a let-in ribbon as provided in Section 2509 (a).

**Vertical
Members or
Assemblies
(Continued)**

2. **Size.** Except as otherwise provided, exterior stud walls and bearing partitions for buildings of two stories or less shall consist of not less than two-inch by four-inch (2" x 4") studs; for buildings of three stories, the studding shall be not less than three inches by four inches (3" x 4") or two inches by six inches (2" x 6") to the bottom of the second floor joists, and two inches by four inches (2" x 4") for the two upper stories.

3. **Height.** Unless supported laterally by adequate framing, the maximum allowable height shall be ten feet (10') for two-inch by three-inch (2" x 3") stud framing; fourteen feet (14') for two-inch by four-inch (2" x 4") stud framing; sixteen feet (16') for three-inch by four-inch (3" x 4") stud framing; and twenty feet (20') for two-inch by six-inch (2" x 6") stud framing.

4. **Spacing.** Except for one-story detached buildings of Group J Occupancy, where twenty-four-inch (24") spacing may be used, no studding shall be spaced more than sixteen inches (16") on center unless vertical supporting members in the walls are designed as columns, or such walls may be constructed of not less than four-inch by four-inch (4" x 4") posts spaced not more than five feet four inches (5'4") on center, or of larger members designed as required in this Chapter, or may be of post and beam framing with plank sheathing not less than one and one-half inches (1½") thick.

5. **Corners and bracing.** Angles or corners where stud walls or partitions meet shall be framed solid. All exterior walls and main cross stud partitions shall be effectively and thoroughly braced or sheathed with approved panels adequately nailed along all edges.

6. **Pipes in walls.** Stud partitions containing plumbing, heating, or other pipes shall be so framed and the joists underneath so spaced as to give proper clearance for the piping. Where a partition containing such piping runs parallel to the floor joists, the joists underneath such partitions shall be doubled and spaced to permit the passage of such pipes and shall be bridged. Where plumbing, heating, or other pipes are placed in or partly in a partition, necessitating the cutting of the soles or plates, a metal tie not less than one-eighth inch (⅛") thick and one and one-half inches (1½") wide shall be fastened to the plate across and to each side of the opening with not less than four 16d nails.

7. **Separations from chimneys.** For clearance space between chimneys and combustible materials, see Section 3702 (j).

8. **Top plates.** In bearing partitions the top plate shall be doubled and lapped at each intersection with walls or partitions. Joints in the upper and lower members of the top plates shall be staggered not less than four feet (4').

9. **Foundation plates.** Stud walls resting on masonry or concrete shall have foundation plates or sills as provided in Sections 2806 (e) and 2517 (c).

10. **Foundation studs.** Foundation studs shall be not less in size than the studding above, and when exceeding four feet (4') in height shall be of the size required for an additional story.

Foundation studs under bearing walls and partitions shall be thoroughly and effectively braced.

11. **Bridging.** All stud partitions or walls over ten feet (10') in height shall have bridging, not less than two inches (2") in thickness and of the same width as the stud, fitted snugly and spiked into the studs at their mid-height, or other means for giving adequate lateral support to the studs. Bridging meeting the requirements of Section 2508 may serve as required firestopping.

12. **Headers.** All openings four feet (4') wide or less in bearing walls shall be provided with headers equivalent to double headers not less than two inches (2") thick, placed on edge, securely fastened together, and all openings more than four feet (4') wide shall be trussed or provided with headers or lintels. Such headers or trusses shall have not less than two-inch (2") solid bearing at each end to the floor or bottom plate, unless other approved framing methods or joint devices are used.

(c) **Walls Without Studs.** Detached one-story buildings of Group J Occupancy may have exterior walls framed without studs when of vertical two-inch (2") or thicker planks, or when having a total floor area of not more than five hundred square feet (500 sq. ft.) may be of vertical one-inch (1") boards and battens.

(d) **Laminated Walls and Partitions.** Walls and partitions may be of laminated construction of not less than four inches (4") nominal thickness, with the structural assembly designed to support all loads.

(e) **Interior Walls and Partitions.** Interior partitions shall be constructed, framed, and firestopped as specified for exterior walls, except that interior nonbearing partitions may have a single top plate. In Group I Occupancies, nonbearing partitions constructed of two-inch by three-inch (2" x 3") studs spaced sixteen inches (16") on center may be used.

Where wood-frame walls and partitions are covered on the interior with plaster, tile, or similar materials and are subject to water splash, the framing shall be protected with 15-pound asphalt-saturated felt.

For provisions covering maximum allowable spacing of gypsum, wood, and fiber insulation lath, see Section 4703.

For provisions covering maximum allowable spacing of supports for metal and wire lath on wood studs and rafters and method of attachment, see Section 4705.

**Vertical
Members or
Assemblies
(Continued)**

For provisions covering maximum allowable spacing of gypsum wallboard on wood studs and rafters and method of attachment, see Section 4715.

(f) **Exterior Wall Coverings.** 1. **General.** Exterior wood stud walls shall be covered on the outside with the materials and in the manner specified in this Section.

2. **Weatherboarding.** Studs or sheathing shall be covered on the outside face with one layer of building paper when required in Section 1707 (a).

Weatherboarding shall have an average thickness in place of not less than five-eighths inch ($\frac{5}{8}$ ") and a minimum thickness of not less than three-eighths inch ($\frac{3}{8}$ "). Horizontal joints in the weatherboarding shall be tongued and grooved or shiplapped joints, or such weatherboarding shall be laid shingle fashion and lapped not less than one-half inch ($\frac{1}{2}$ ").

Siding patterns known as rustic, drop siding, or shiplap shall have an average thickness in place of not less than nineteen thirty-seconds inch ($\frac{19}{32}$ ") and shall have a minimum thickness of not less than three-eighths inch ($\frac{3}{8}$ "). Bevel siding shall have a minimum thickness measured at the butt section of not less than seven-sixteenths inch ($\frac{7}{16}$ ") and a tip thickness of not less than three-sixteenths inch ($\frac{3}{16}$ "). Siding of lesser dimensions may be used, provided such wall covering is placed over sheathing which conforms to the provisions specified in Section 2202.

All weatherboarding or siding shall be securely nailed to each stud with not less than one nail, or to solid nominal wood sheathing with not less than one line of nails spaced not more than twenty-four inches (24") on center in each piece of the weatherboarding or siding.

Nails shall be so located as to hold the bottom of the weatherboarding or siding secure and thereby to hold tight the top of the piece below. Where such nailing is not possible, two nails to each stud shall be used to hold each piece.

3. **Plywood.** Where plywood is used for covering the exterior of outside walls, it shall be of the exterior type not less than three-eighths inch ($\frac{3}{8}$ ") thick. Joints shall occur over framing members not less than two inches (2") thick, unless wood or plywood sheathing is used, or joints are lapped horizontally or otherwise made waterproof to the satisfaction of the Building Official.

4. **Shingles or shakes.** Wood shingles or shakes and asbestos cement shingles may be used for exterior wall covering provided the frame of the structure is covered with building paper as specified in Section 1707 (a). All shingles or shakes attached to sheathings other than wood shall be secured with approved mechanically-bonding nails or by approved corrosion-resistant nails on furring strips attached to the studs. Wood shingles or shakes may be applied over fiberboard

shingle backer and sheathing with annular, grooved nails. The thickness of wood shingles or shakes between wood nailing boards shall be not less than three-eighths inch ($\frac{3}{8}$ ").

5. **Weather-resistant metal.** Painted, treated, or noncorrosive metal may be used on stud walls. When sheathing is omitted the installation must be approved by the Building Official. Contact between dissimilar metals shall be broken by approved methods. Galvanized steel sheets formed or flat may be used.

6. **Exterior plastering.** See Chapter 47.

7. **Masonry veneer.** See Chapter 29.

Sec. 2508. Firestopping shall be provided to cut off all concealed draft openings (both vertical and horizontal), and form an effective barrier between stories, and between a top story and roof space. It shall be used in specific locations, as follows:

1. In exterior or interior stud walls, at ceilings and floor levels.

2. In all stud walls and partitions, including furred spaces, so placed that the maximum dimension of any concealed space is not over eight feet (8').

3. Between stair stringers at least once in the middle portion of each run, at top and bottom, and between studs, along and in line with run of stair adjoining stud walls and partitions.

4. Around top, bottom, sides, and ends of sliding door pockets.

5. In spaces between chimneys and wood framing, loose incombustible materials shall be placed in incombustible supports, or a metal collar tightly fitted to the chimney and nailed to the wood framing may be used.

6. Any other locations not specifically mentioned above, such as holes for pipes, shafting, behind furring strips and similar places which could afford a passage for flames.

Firestops when of wood shall be two-inch (2") nominal thickness. If width of opening is such that more than one piece of lumber is necessary, there shall be two thicknesses of one-inch (1") material with joints broken.

Sec. 2509. (a) Bearing. Every beam, girder, and joist shall have sufficient bearing area so that the compression perpendicular to grain values set forth in Table No. 25-A, No. 25-D, No. 25-E, or No. 25-F are not exceeded.

EXCEPTIONS: 1. Two-inch (2") joists when nailed to adjacent studs may be supported on a one-inch (1") let-in ribbon.

2. Approved devices or other manner of support may be used in lieu of bearing.

**Vertical
Members or
Assemblies
(Continued)**

Firestops

**Horizontal
Members or
Assemblies**

**Horizontal
Members or
Assemblies
(Continued)**

Wood members bearing on or in contact with masonry or concrete at or below adjacent ground level shall be as specified for foundation plates in Section 2517 (c).

(b) **Built-up Members.** 1. **Beams.** Laminated built-up beams with through lamination not less than two inches (2") in nominal thickness may be used in place of solid timbers when the laminations are parallel to applied loads. Laminated beams ten inches (10") or less in depth may be spiked together with not less than 16d spikes at twelve-inch (12") centers, staggered. Unless so spiked, or if the depth of beam is more than ten inches (10"), the laminations shall be connected together with bolts not smaller than one-half-inch ($\frac{1}{2}$ ") diameter spaced not over two feet (2') apart, staggered or equal. Fastenings shall be placed at a maximum of one-fourth the depth of the member from the top and bottom edges.

2. **Trusses.** The design, fabrication, and erection of timber trusses shall conform to the provisions of this Code.

(c) **Joist and Rafter Blocking and Bridging.** Rafters of more than eight-inch (8") depth and joists of more than four-inch (4") depth shall be stabilized against overturning or bridging from superimposed load as follows:

1. At ends and at each support, by solid blocking of not less than two-inch (2") thickness and the full depth of joists, by nailing to studs when supported by ribbon boards, or by approved hangers or fastenings.

2. Between supports as required so that joists will be stabilized every eight feet (8') and rafters every ten feet (10') by solid blocking two inches (2") thick and the full depth of the joist or rafter, or by wood cross bridging of not less than one inch by three inches (1" x 3") or metal cross bridging of equal strength. Where cross bridging is used, the lower ends of such cross bridging shall be driven up and nailed after the floor or subfloor has been nailed.

(d) **Joists under Bearing Partitions.** Joists under and parallel to bearing partitions shall be doubled and well spiked, or may be separated by solid blocking spaced at no more than four-foot (4') intervals.

(e) **Headers.** Header joists over six feet (6') long and tail joists over twelve feet (12') long shall be hung in joist or beam hangers or framing anchors or secured by other devices or methods affording equivalent support. Trimmers and header joists more than four feet (4') long shall be doubled. Headers shall be not less than twenty inches (20") from face of chimney breast. Trimmers and headers shall be provided with clearance from flues, chimneys, and fireplaces as specified in Sections 3702 (l) and 3711 (g).

(f) **Wood Members Entering Masonry or Concrete.** The ends of wood members entering masonry or concrete walls from opposite sides shall be separated by not less than four inches (4") of solid masonry. Other wood members shall be set back not less than four inches (4") from the exterior face of walls, except on street fronts.

Ends of wood beams or joists entering masonry or concrete walls, unless pressure-impregnated with an approved preservative, shall be provided with a one-half-inch ($\frac{1}{2}$ ") air space on sides and end.

Ends of wood beams or joists entering masonry or concrete walls shall be beveled so that top edge does not enter more than one inch (1").

Where timbers extend into a masonry wall at a point below the level of the ground outside of the wall, metal wall boxes shall be provided on the end and all surfaces of the timber within one foot (1') of the end shall be painted with at least two coats of hot coal-tar creosote or other approved wood preservative.

(g) **Anchors and Ties.** For anchorage of wood joists or beams to masonry walls or concrete walls, see Section 2312.

(h) **Floors.** See Sections 2514 and 2515.

(i) **Roofs.** See Sections 2514 and 2515.

Sec. 2510. (a) Dead Load. Wood members shall not be used to support the dead load of any masonry or concrete.

EXCEPTIONS: 1. Masonry or concrete nonstructural floor surfacing not more than four inches (4") thick may be supported by wood members.

2. Any structure may rest upon wood piles constructed in accordance with the requirements of Chapter 28.

(b) **Horizontal Force.** Wood members shall not be used to resist horizontal forces contributed by masonry or concrete construction in buildings over one story in height.

EXCEPTION: Wood floor and roof members may be used in horizontal trusses and diaphragms to resist horizontal forces imposed by wind, earthquake, or earth pressure, provided such forces are not resisted by rotation of the truss or diaphragm.

Sec. 2511. (a) General. Wood and plywood diaphragms may be used to resist horizontal forces in horizontal and vertical distributing or resisting elements, provided the deflection in the plane of the diaphragm, as determined by calculations, tests, or analogies drawn therefrom, does not exceed the permissible deflection of attached distributing or resisting elements.

Permissible deflection shall be that deflection up to which the diaphragm and any attached distributing or resisting ele-

**Horizontal
Members or
Assemblies
(Continued)**

**Wood Combined
with Masonry
or Concrete**

**Wood
Diaphragms**

**Wood
Diaphragms
(Continued)**

ment will maintain its structural integrity under assumed load conditions, i. e., continue to support assumed loads without danger to occupants of the structure.

Connections and anchorages capable of resisting the design forces shall be provided between the diaphragms and the resisting elements. Openings in diaphragms which materially affect their strength shall be fully detailed on the plans, and shall have their edges adequately reinforced to transfer all shearing stresses.

Size and shape of diaphragms shall be limited as set forth in Table No. 25-M.

In buildings of wood construction where rotation is provided for, transverse shear resisting elements normal to the longitudinal element shall be provided at spacings not exceeding one and one-half times the width for conventional diagonally sheathed diaphragms or two times the width for special diagonally sheathed or plywood diaphragms.

In masonry or concrete buildings wood and plywood diaphragms shall not be considered as transmitting lateral forces by rotation.

(b) **Diagonally Sheathed Diaphragms.** 1. **Conventional construction.** Such wood diaphragms shall be made up of one-inch (1") nominal sheathing boards laid at an angle of approximately 45 degrees to supports. Sheathing boards shall be directly nailed to each intermediate bearing member with not less than two 8d nails for one-inch by six-inch (1" x 6") boards and three 8d nails for boards eight inches (8") or wider, and in addition three 8d nails and four 8d nails shall be used for six-inch (6") and eight-inch (8") boards, respectively, at the diaphragm boundaries. End joints in adjacent boards shall be separated by at least one joist or stud space, and there shall be at least two boards between joints on the same support. Boundary members at edges of diaphragms shall be designed to resist direct tensile or compressive chord stresses and shall be adequately tied together at corners.

Conventional wood diaphragms may be used to resist shears, due to wind or seismic forces, not exceeding 300 pounds per lineal foot of width.

TABLE NO. 25-M—MAXIMUM DIAPHRAGM DIMENSION RATIOS

	HORIZONTAL DIAPHRAGMS	VERTICAL DIAPHRAGMS
	Maximum Span-Width Ratios	Maximum Height-Width Ratios
1. Diagonal sheathing, conventional	3:1	2:1
2. Diagonal sheathing, special	4:1	3½:1
3. Plywood, nailed all edges	4:1	3½:1
4. Plywood, blocking omitted at intermediate joints	4:1	2:1

2. Special construction. Special diagonally sheathed diaphragms shall conform to conventional construction and, in addition, shall have all elements designed in conformance with the provisions of this Code.

**Wood
Diaphragms
(Continued)**

Each chord or portion thereof may be considered as a beam, loaded with a uniform load per foot equal to 50 per cent of the unit shear due to diaphragm action. The load shall be assumed as acting normal to the chord, in the plane of the diaphragm and either toward or away from the diaphragm. The span of the chord, or portion thereof, shall be the distance between structural members of the diaphragm such as the joists, studs, and blocking, which serve to transfer the assumed load to the sheathing.

Special diagonally sheathed diaphragms shall include conventional diaphragms sheathed with two layers of diagonal sheathing at 90 degrees to each other and on the same face of the supporting members.

Special diagonally sheathed diaphragms may be used to resist shears, due to wind or seismic loads, provided such shears do not stress the nails beyond their allowable safe lateral strength and do not exceed 600 pounds per lineal foot of width.

(c) **Plywood Diaphragms.** Horizontal and vertical diaphragms sheathed with plywood may be used to resist horizontal forces not exceeding those set forth in Table No. 25-N, or may be calculated by principles of mechanics without limitation by using values of nail strength and plywood shear values as given elsewhere in this Code. Plywood thickness for horizontal diaphragms shall be not less than that set forth in Tables No. 25-O and No. 25-P for corresponding joist spacing and loads, except that one-fourth-inch ($\frac{1}{4}$ ") plywood may be used where perpendicular loads permit. Plywood used for horizontal and vertical diaphragms shall conform to U.B.C. Standard No. 25-9-64.

All boundary members shall be proportioned and spliced where necessary to transmit direct stresses. Framing members shall be at least one and five-eighths inches ($1\frac{5}{8}$ ") wide. In general, panel edges shall bear on the framing members and butt along their center lines. Nails shall be placed not less than three-eighths inch ($\frac{3}{8}$ ") in from the panel edge, not more than twelve inches (12") apart along intermediate supports and six inches (6") along panel edge-bearings, and shall be firmly driven into the framing members. No unblocked panels less than twelve inches (12") wide shall be used.

Sec. 2512. Stressed skin panels shall be designed in accordance with U.B.C. Standard No. 25-18-64.

**Stressed
Skin Panel
Design**

Sec. 2513. (a) Design and Allowable Unit Stresses. 1. General. Glued-laminated and glued built-up structural members shall be designed by the applicable engineering formulas

**Design of
Glued-Laminated
Lumber**

TABLE NO. 25-N—ALLOWABLE SHEAR IN POUNDS PER FOOT FOR PLYWOOD DIAPHRAGM

THICKNESS OF PLYWOOD (In Inches)	COMMON NAIL SIZE	NOMINAL WIDTH OF FRAMING MEMBERS (In Inches)	PLYWOOD SPECIES ¹	BLOCKED DIAPHRAGMS ² UNIFORM NAIL SPACING ON ALL PANEL EDGES			UNBLOCKED DIAPHRAGM ³ WITH NAILS SPACED 6" O.C. AT SUPPORTED EDGES	
				6"	4"	3"	Load Perpendicular to Unblocked Edges and Continuous Panel Joints	All Other Panel Arrangements
$\frac{1}{8}$	6d	Not less than 2	Douglas Fir	141	210	236	125	94
			Western Softwood	94	137	158	83	63
		3 or More	Douglas Fir	158	236	266	140	105
			Western Softwood	105	157	178	94	70
$\frac{3}{8}$	8d	Not less than 2	Douglas Fir	202	298	338	180	135
			Western Softwood	135	198	225	120	90
		3 or More	Douglas Fir	225	338	380	200	150
			Western Softwood	150	225	254	133	100
$\frac{1}{2}$	10d	Not less than 2	Douglas Fir	239	360	410	212	159
			Western Softwood	160	240	274	142	106
		3 or More	Douglas Fir	270	405	462	240	180
			Western Softwood	180	270	308	160	120

¹Plywood shall be identified as structural interior or exterior. All values may be increased one-third except for Douglas fir plywood identified as made with Western Softwood inner-plyes and Douglas fir plywood identified as Interior Types A-A, A-B, A-D, B-D and C-D (plugged).

²These values may be increased one-third provided the nail spacing is reduced one-third at the diaphragm boundary and at continuous panel joints. Tongue and groove plywood shall be designed as an unblocked diaphragm.

³Where tongue and groove plywood is used for diaphragms, panels shall be tongue and grooved on sides only and a minimum edge nailing distance of seven-eighths inch ($\frac{7}{8}$ ") shall be provided for nails installed in tongue and groove edges at diaphragm boundary locations.

used for sawn members, plywood, and as otherwise provided without exceeding the allowable unit stresses specified in Section 2504 as modified in this Section.

**Design of
Glued-Laminated
Lumber
(Continued)**

2. **Curvature factor.** For the curved portion of members, the allowable stress in bending shall be modified by multiplication by the following curvature factor:

$$1 - 2000 \left(\frac{t}{R} \right)^2$$

WHERE:

t = thickness of lamination in inches,

R = radius of curvature of a lamination in inches,

and " t/R " shall not exceed 1/125 for softwoods and 1/100 for hardwoods. No curvature factor shall be applied to stress in the straight portion of an assembly regardless of curvature elsewhere.

3. **Radial tension or compression.** The radial stress induced by a bending moment in a curved rectangular member shall be limited to the allowable stress " S_R " when computed by the equation

$$S_R = \frac{3M}{2Rbh}$$

WHERE:

M = bending moment in inch pounds

R = radius of curvature at center line of member in inches.

When " M " is in the direction tending to decrease curvature (increase the radius), the stress is in tension and shall be limited to an allowable stress equal to one-third the allowable stress in shear.

When " M " is in the direction tending to increase curvature (decrease radius), the stress is in compression and shall be limited to the allowable stress in compression perpendicular to grain.

4. **Reduction for depth.** The allowable unit flexural stresses in rectangular shaped beams over twelve inches (12") in depth shall not exceed the value established by multiplying such stress by the depth factor as determined in the following formula:

$$F_d = .81 \left(\frac{H^2 + 143}{H^2 + 88} \right)$$

WHERE:

H = Depth of beam, in inches.

F_d = Depth factor.

**Design of
Glued-Laminated
Lumber
(Continued)**

5. **Form factors.** The allowable unit flexural stresses in nonprismatic members shall not exceed the value established by multiplying such stress by the form factor determined as follows:

BEAM SECTION	FORM FACTOR (F_f)
Circular.....	1.180
Square (with diagonal vertical).....	1.414
I and Box Beams.....	$0.81 + S (F_d - .81)$

WHERE:

F_f = Form factor.

F_d = Depth factor determined in accordance with Section 2513 (a) 4.

S = Support factor = $P^2 (6 - 8P + 3P^2) (1 - q) + q$.

P = Ratio of depth of compression flange to full depth of beam.

q = Ratio of thickness of web or webs to the full width of beam.

6. **Tapered faces.** No taper shall be permitted on the tension side of any simple beam.

For other members subject to bending, the slope of tapered faces, measured from the tangent to the lamination of the section under consideration, shall be not steeper than 1:24 on the tension side.

EXCEPTIONS: 1. This requirement shall not apply to arches.

2. Taper may be steeper at sections increased in size beyond design requirements for architectural projections.

7. **Width.** Allowable stresses for the various combinations are based on standard finished widths at the time of grading. Where beam widths are further reduced in finishing such re-

**TABLE NO. 25-O—MINIMUM THICKNESS AND MAXIMUM SPAN¹
FOR PLYWOOD FLOORS**

MINIMUM THICKNESS OF PLYWOOD (In Inches)	MAXIMUM SPACING OF JOISTS ² (In Inches)	
	Douglas Fir	Western Softwood Groups I ³ and II
1/2	16	Not Permitted
5/8	20	16
3/4	24	24

¹Plywood continuous over two or more spans and face grain perpendicular to supports. Allowable uniform load based on deflection of 1/360 is 100 pounds per square foot. Spans limited to values shown because of possible effect of concentrated loads.

²Blocking shall be installed at unsupported edges or edges shall otherwise be supported by approved tongue-and-groove joint, except where twenty-five thirty-seconds-inch ($\frac{3}{32}$ ") finish floor or a separate underlayment is used, edge supports shall not be required. The thickness of Douglas fir may be reduced to not less than one-half inch ($\frac{1}{2}$ ") for the sixteen-inch (16") and twenty-four-inch (24") spans where a twenty-five thirty-seconds-inch ($\frac{3}{32}$ ") finish floor is applied perpendicular to the supports.

³When identified as Group I, interior type Grade C-D and exterior type Grade C-C may be used with Douglas fir spans.

**TABLE NO. 25-P—MINIMUM THICKNESS AND MAXIMUM SPANS¹
PLYWOOD ROOF SHEATHING**

Design of
Glued-Laminated
Lumber
(Continued)

THICKNESS OF PLYWOOD (In Inches)	LIVE LOAD (In Pounds Per Square Foot)	MAXIMUM SPACING OF RAFTERS (Inches) ²			
		DOUGLAS FIR		SOFTWOOD GROUPS I ³ AND II	
		Blocked ³ or Other Approved Type of Edge Support	Unblocked	Blocked or Other Approved Type of Edge Support	Unblocked
$\frac{1}{8}$ "	20, 30 or 40	16	12	16	Not Permitted
$\frac{3}{8}$ "	20, 30 or 40	24	16	20	Not Permitted
$\frac{1}{2}$ "	20 or 30	32	24	26	24
	40	30	24	26	24
$\frac{5}{8}$ "	20 or 30	42	32	35	28
	40	36	32	34	28
$\frac{3}{4}$ "	20 or 30	48	36	40	32
	40	42	36	37	32

¹Plywood continuous over two or more spans; and face grain perpendicular to supports.

²When identified as Group I, Interior type Grade C-D and exterior type Grade C-C may be used with Douglas fir spans.

³One-half-inch ($\frac{1}{2}$ ") five-ply panels of 100 per cent Douglas fir, when continuous over one support, may be laid with face grain parallel to the supports provided all panel edges are blocked or other approved type edge support is provided, the spacing of the supports does not exceed twenty-four inches (24") on center, and the live load does not exceed 30 pounds per square foot.

⁴These values are for interior type Grade C-D and exterior type Grade C-C only.

duction shall be considered in determination of allowable stresses.

(b) **Fastenings.** The methods of design of bolts and connectors and their allowable loads when used with glued-laminated lumber, shall be the same as provided for their use with sawn lumber.

(c) **Fabrication of Members.** 1. **General.** Structural glued laminated lumber shall be fabricated in accordance with good practice and as set forth in the applicable U.B.C. Standards Nos. 25-10-64 and 25-11-64.

All work shall be under the supervision of qualified personnel.

2. **Laminations.** The individual laminations in structural glued laminated lumber shall be not more than two inches (2") in thickness and all such laminations in the stressed portion shall be approximately parallel to the neutral plane of the member.

**Design of
Glued-Laminated
Lumber
(Continued)**

3. **Lumber grade.** The lumber, at the time of laminating, shall conform to the grade and species specified.

4. **Moisture content.** The maximum moisture content of the wood at the time of gluing shall not exceed 18 per cent and shall be not less than seven per cent. The range of moisture content of laminations assembled into a single member shall not exceed five per cent at the time of gluing.

5. **Surfaces.** Surfaces to be glued shall be free from dust, dirt, and grease. Each lamination shall be smoothly surfaced and be of uniform thickness with a maximum allowable variation of one sixty-fourth inch ($\frac{1}{64}$ ") for softwoods and one one-hundredth inch ($\frac{1}{100}$ ") for hardwoods. Lumber surfaces shall not be sanded before gluing, except that factory-sanded plywood shall not be prohibited.

6. **Joints.** Joints in structural glued laminated lumber shall make the contact surfaces between two adjacent pieces of wood glued together. An edge or face joint is parallel to the grain of the wood. An end joint is at right angles to the grain of the wood. A scarf joint is a sloping or bevel joint, where pieces of wood are lapped together.

(d) **Adhesives.** 1. **General.** Adhesives shall cover structural gluing, exclusive of plywood. Adhesives shall provide an adequate bond, shall subject the wood to no deleterious chemical reactions, and shall withstand without deterioration the expected conditions of service.

2. **Quality.** Adhesives shall conform to U.B.C. Standard No. 25-19-64.

3. **Use.** Interior type adhesive may be used only in interior and protected locations where moisture content of the wood will not exceed 15 per cent.

Exterior type adhesive may be used under any conditions of exposure and shall be used where subjected to high humidity.

4. **Tests.** Where sufficient evidence of the quality of adhesive to be used is not available, the Building Official may require tests to be made as set forth in U.B.C. Standards Nos. 25-19-64 and 25-20-64.

5. **Adhesive application.** Gluing practices shall take into consideration the characteristics and limitations of the specific adhesive used, and shall conform to good practices as to preparation of wood surfaces for gluing, control of temperature and moisture content of materials, maintenance of adequate pressures, and compatibility of the adhesive with any other wood treatments employed. Mixing, spreading, storage life, pot life, working life, and assembly-time life shall be in accordance with the recommendations of the manufacturer of the adhesive used.

(e) **Inspection.** 1. **Inspection agencies.** All structural glued-laminated lumber shall be inspected during lamination by an approved inspection agency.

2. **Certificate of inspection.** Each structural glued-laminated member shall be stamped with an identifying number and shall be accompanied by a certificate of inspection as required in Section 5006 (b).

**Design of
Glued-Laminated
Lumber
(Continued)**

Sec. 2514. (a) **Columns.** Wood columns may be sawn or glued-laminated and shall be not less than eight inches (8") nominal in any dimension when supporting roof or floor loads, except as specified in Section 2514 (c) 1.

**Heavy Timber
Construction**

Columns shall be continuous or superimposed by means of reinforced concrete or metal caps with brackets, or shall be connected by properly designed steel or iron caps, with pin-tles and base plates, or by timber splice plates affixed to the columns by means of metal connectors housed within the contact faces, or by other approved methods.

(b) **Floor Framing.** Beams and girders of wood may be sawn or glued-laminated and shall be not less than six inches (6") nominal in width and not less than ten inches (10") nominal in depth.

Framed or glued-laminated arches which spring from the floor line and support floor loads shall be not less than eight inches (8") nominal in any dimension.

Framed timber trusses supporting floor loads shall have members of not less than eight inches (8") nominal in any dimension.

(c) **Roof Framing.** Framed or glued-laminated arches for roof construction which spring from the floor line and do not support floor loads shall have members not less than six inches (6") nominal in width and not less than eight inches (8") nominal in depth for the lower half of the height and not less than six inches (6") nominal in depth for the upper half.

Framed or glued-laminated arches for roof construction which spring from the top of walls or wall abutments, framed timber trusses, and other roof framing which do not support floor loads, shall have members not less than four inches (4") nominal in width and not less than six inches (6") nominal in depth. Spaced members may be composed of two or more pieces not less than three inches (3") nominal in thickness when blocked solidly throughout their intervening spaces or when such spaces are tightly closed by a continuous wood cover plate of not less than two inches (2") nominal in thickness, secured to the underside of the members. Splice plates shall be not less than three inches (3") nominal in thickness. When protected by approved automatic sprinklers under the roof deck, framing members shall be not less than three inches (3") nominal in thickness.

**Heavy Timber
Construction
(Continued)**

(d) **Construction Details.** Approved wall plate boxes or hangers shall be provided where wood beams, girders or trusses rest on masonry or concrete walls. An air space of one-half inch ($\frac{1}{2}$ ") shall be provided at the top, end and sides of the member unless approved durable or treated wood is used.

Girders and beams shall be closely fitted around columns and adjoining ends shall be cross tied to each other, or intertied by caps or ties, to transfer horizontal loads across the joint. Wood bolsters may be placed on top of columns which support roof loads only.

Where intermediate beams are used to support a floor, they shall rest on top of the girders, or shall be supported by ledgers or blocks securely fastened to the sides of the girders, or they may be supported by approved metal hangers into which the ends of the beams shall be closely fitted.

In heavy timber roof construction, every roof girder and at least every alternate roof beam shall be anchored to its supporting member; roof planking where supported by a wall shall be anchored to such wall at intervals not exceeding twenty feet (20'); every monitor and every sawtooth construction shall be anchored to the main roof construction. Such anchors shall consist of steel or iron bolts of sufficient strength to resist vertical uplift of the roof.

(e) **Heavy Timber Floors.** Floors shall be without concealed spaces. Floors shall be of sawn or glued-laminated plank, splined, or tongue-and-groove, of not less than three inches (3") nominal in thickness covered with one-inch (1") nominal dimension tongue-and-groove flooring, laid crosswise or diagonally, or of planks not less than four inches (4") nominal in width set on edge close together and well spiked, and covered with one-inch (1") nominal dimension flooring. The planks shall be laid so that no continuous line of joints will occur except at points of support. Flooring shall not extend closer than one-half inch ($\frac{1}{2}$ ") to walls. Such one-half-inch ($\frac{1}{2}$ ") space shall be covered by a molding fastened to the wall and so arranged that it will not obstruct the swelling or shrinking movements of the floor. Corbeling of masonry walls under floor planks may be used in place of such molding.

(f) **Heavy Timber Roof Decks.** Roofs shall be without concealed spaces and roof decks shall be sawn or glued-laminated, splined or tongue-and-groove plank, not less than two inches (2") nominal in thickness or of a double thickness of one-inch (1") nominal thickness boards with tongued and grooved joints or with staggered joints, or of planks not less than three inches (3") nominal in width, set on edge close together and laid as required for floors. Other types of decking may be used when approved by the Building Official as being equal.

(g) **Mechanically Laminated Floors and Decks.** A laminated lumber floor or deck built up of wood members set on edge, when meeting the following requirements, may be designed as a solid floor or roof deck of the same thickness, and continuous spans may be designed on the basis of the full cross section using the simple span moment coefficient.

Laminations shall be driven up and spiked closely together with a row of nails near each edge at spaced intervals and staggered vertically. Nail spacing in each row shall not exceed eighteen inches (18") for two-inch by eight-inch (2" x 8") nominal width and be proportional for other plank widths. Nail length shall be not less than two and one-half times the net thickness of each lamination.

A single span deck shall have all laminations full length.

A continuous deck of two spans shall have not more than every fourth lamination spliced within quarter points adjoining supports.

A continuous deck of more than two spans shall have not more than every third lamination spliced within quarter points adjoining supports.

Joints shall be closely butted over supports or staggered across the deck but within the adjoining quarter spans.

No lamination shall be spliced more than twice in any span.

Sec. 2515. (a) General. In one- and two-story buildings housing Groups H, I and J Occupancies, where engineering design is not provided, where the floor live load does not exceed 50 pounds per square foot, and where the roof live load does not exceed 20 pounds per square foot, Tables Nos. 25-L, 25-O, 25-P, 25-Q, 25-R, 25-S, 25-T and 25-U may be used to determine framing requirements based upon the general design requirements set forth in U.B.C. Standard No. 25-21-64. The allowable span of horizontal load-bearing members shall be taken as the clear horizontal distance between supports.

(b) **Roof Construction.** There shall be a ridge board at least one inch (1") thick at all ridges, not less in depth than the cut end of the rafter. Where the slope of the roof is less than three in 12, the ridge member shall be designed as a vertical load-bearing member. At all valleys and hips there shall be a valley or hip rafter not less than two inches (2") thick and not less in depth than the cut end of the rafter.

Where the ridge member is not designed as a vertical load-bearing member, rafters shall be framed directly opposite each other at the ridge and shall be nailed to adjacent ceiling joists to form a continuous tie between exterior walls. Where the ceiling joists run other than parallel to the rafters, rafters

**Heavy Timber
Construction
(Continued)**

**Light Frame
Construction**

TABLE NO. 25-Q—ALLOWABLE SPANS FOR FLOOR JOISTS USING NONSTRESS-GRADED LUMBER¹

SIZE OF FLOOR JOISTS (Inches)	SPACING OF FLOOR JOISTS (Inches)	MAXIMUM ALLOWABLE SPAN (Feet and Inches)							
		GROUP I		GROUP II		GROUP III		GROUP IV ²	
		Plastered Ceiling Below	Without Plastered Ceiling Below	Plastered Ceiling Below	Without Plastered Ceiling Below	Plastered Ceiling Below	Without Plastered Ceiling Below	Plastered Ceiling Below	Without Plastered Ceiling Below
2 x 6	12	10-6	11-6	9-0	10-0	7-6	8-0	5-6	6-0
	16	9-6	10-0	8-0	8-6	6-6	7-0	5-0	5-0
	24	7-6	8-0	6-6	7-0	5-6	6-0	4-0	4-0
2 x 8	12	14-0	15-0	12-6	13-6	10-6	11-6	8-0	8-6
	16	12-6	13-6	11-0	11-6	9-0	10-0	7-0	7-6
	24	10-0	11-0	9-0	9-6	7-6	8-0	6-0	6-6
2 x 10	12	17-6	19-0	16-6	17-6	13-6	14-6	10-6	11-6
	16	15-6	16-6	14-6	15-6	12-0	13-0	9-6	10-0
	24	13-0	14-0	12-0	13-0	10-0	10-6	7-6	8-6
2 x 12	12	21-0	23-0	21-0	21-6	17-6	19-0	13-6	14-6
	16	18-0	20-0	18-0	19-6	15-6	16-6	12-0	13-0
	24	15-0	16-6	15-0	16-6	12-6	13-6	10-0	10-6
DESIGN LOADING AND DEFLECTION CRITERIA:									
Live load—Forty pounds per square foot ³ ; Dead load weight of floor—Five pounds per square foot—plus weight of joists; eight pounds per square foot—weight of lath and plaster; Deflection with or without plaster—Not to exceed 1/360th of the span with live load nor 1/240th with dead load and live load.									

¹Species of lumber are divided into groups as set forth in Table No. 25-G. The allowable spans are based upon stress and deflection criteria set forth in U.B.C. Standard No. 25-21-64. Span lengths for stress-graded lumber as set forth in Table No. 25-A may be based on the stresses therein. Spans in Group I are suitable for any species of stress-graded lumber given in Table No. 25-A which has a modulus of elasticity of 1,600,000 pounds per square inch and an allowable extreme fiber stress in bending of 1100 pounds per square inch.

²Lumber in Group IV may be used only under conditions specifically approved by the Building Official.

³For live loads of 50 pounds per square foot, spans shall be reduced to 90 per cent of the tabulated values.

shall be tied back to the roof framework by means of cross ties spaced not less than forty-eight inches (48") on center. Such cross ties shall be not less in size than one inch by four inches (1" x 4").

Purlins to support roof loads may be installed to reduce span of rafters within allowable limitations and shall be supported by struts from bearing walls or partitions. Struts shall be not smaller than two inches by four inches (2" x 4"). The unbraced length of struts shall not exceed eight feet (8') and the slope of said struts shall be not less than 45 degrees from the horizontal.

(c) **Girders.** Girders supporting first floor joists shall be not less than four inches by four inches (4" x 4") for spans five feet (5') or less, or not less than four inches by six inches (4" x 6") (placed on edge) for spans not more than seven feet (7').

(d) **Plank and Beam Construction.** Floor and roof systems of plank and beam construction may be designed as provided in this Code, or may be as set forth in U.B.C. Standard No. 25-22-64. When used for light frame construction, spans for planking may be as set forth in Table No. 25-U. Loading shall be as specified in the notes of said table.

**Light Frame
Construction
(Continued)**

**TABLE NO. 25-R—ALLOWABLE SPANS FOR CEILING JOISTS USING
NONSTRESS-GRADED LUMBER¹**

Size of Ceiling Joists (Inches)	Spacing of Ceiling Joists (Inches)	MAXIMUM ALLOWABLE SPAN (Feet and inches)			
		GROUP I	GROUP II	GROUP III	GROUP IV ²
2 x 4	12	11-6	11-0	9-6	5-6
	16	10-6	10-0	8-6	5-0
2 x 6	12	18-0	16-6	15-6	12-6
	16	16-0	15-0	14-6	11-0
2 x 8	12	24-0	22-6	21-0	19-0
	16	21-6	20-6	19-0	16-6
DESIGN LOADING AND DEFLECTION CRITERIA:					
Live Load—None. Dead Load—Ten pounds per square foot—weight of joists and lath and plaster; Deflection—Not to exceed 1/360 of the span.					

¹Species of lumber are divided into groups as set forth in Table No. 25-C.

Span lengths for stress-graded lumber as set forth in Table No. 25-A may be based on the stresses therein. Spans in Group I are suitable for any species of stress-graded lumber given in Table No. 25-A which has a modulus of elasticity of 1,600,000 pounds per square inch and an allowable extreme fiber stress in bending of 1100 pounds per square inch. The allowable spans are based upon stress and deflection criteria set forth in U.B.C. Standard No. 25-21-64.

²Lumber in Group IV may be used only under conditions specifically approved by the Building Official.

Light Frame
Construction
(Continued)

TABLE NO. 25-S—ALLOWABLE SPANS FOR RAFTERS'
(Slopes 4:12 or greater)

SIZE OF RAFTER (Inches)	SPACING OF RAFTER (Inches)	MAXIMUM ALLOWABLE SPAN (Feet and inches)			
		Group I	Group II	Group III	Group IV ²
2 x 4	12	10-0	9-0	7-0	4-0
	16	9-0	7-6	6-0	3-6
	24	7-6	6-6	5-0	3-0
	32	6-6	5-6	4-6	2-6
2 x 6	12	17-6	15-0	12-6	9-0
	16	15-6	13-0	11-0	8-0
	24	12-6	11-0	9-0	6-6
	32	11-0	9-6	8-0	5-6
2 x 8	12	23-0	20-0	17-0	13-0
	16	20-0	18-0	15-0	11-6
	24	17-0	15-0	12-6	9-6
	32	14-6	13-0	11-0	8-6
2 x 10	12	28-6	26-6	22-0	17-6
	16	25-6	23-6	19-6	15-6
	24	21-0	19-6	16-0	12-6
	32	18-6	17-0	14-0	11-0
DESIGN LOADING CRITERIA:					
Live Load—16 pounds per square foot on horizontal projection. Dead load weight of roof—seven pounds per square foot on horizontal projection plus weight of rafters.					

¹Species of lumber are divided into groups as set forth in Table No. 25-G. Allowable stresses increased 25 per cent for roof loading [Section 2504 (c) 2]. Span length for stress-graded lumber set forth in Table No. 25-A may be based on the stresses therein. Spans in Group I are suitable for any species of stress-graded lumber given in Table No. 25-A which has a modulus of elasticity of 1,600,000 pounds per square inch and an allowable extreme fiber stress in bending of 1100 pounds per square inch. The allowable spans are based upon stress and deflection criteria set forth in U.B.C. Standard No. 25-21-64.

²Lumber in Group IV may be used only under conditions specifically approved by the Building Official.

Species of lumber are divided into groups as set forth in Table No. 25-G.

Span lengths for grades given in Table No. 25-A may be based on the stresses therein.

Joints and planking may be randomly spaced provided the system is applied to not less than three continuous spans, planks are center-matched and end-matched or splined, each plank bears on at least one support and joints are separated by at least twenty-four inches (24") in adjacent pieces. One-inch (1") nominal strip square edged flooring, one-half-inch ($\frac{1}{2}$ ") tongue and groove flooring, or three-eighths-inch ($\frac{3}{8}$ ") plywood shall be applied over random length decking used as a floor. The "strip" and tongue and groove flooring shall be applied at right angles to the span of the planks. The three-

TABLE NO. 25-T—ALLOWABLE SPANS FOR ROOF RAFTERS USING NONSTRESS-GRADED LUMBER¹
(Slopes less than 4:12)

SIZE OF ROOF RAFTERS (Inches)	SPACING OF ROOF RAFTERS (Inches)	MAXIMUM ALLOWABLE SPAN (Feet and Inches Measured Along the Horizontal Projection)							
		GROUP I		GROUP II		GROUP III		GROUP IV ²	
		Supporting Ceiling	Not Supporting Ceiling	Supporting Ceiling	Not Supporting Ceiling	Supporting Ceiling	Not Supporting Ceiling	Supporting Ceiling	Not Supporting Ceiling
2 x 4	12	8-0	9-6	7-0	8-0	5-6	6-6	3-0	4-0
	16	7-0	8-0	6-0	7-0	5-0	5-6	3-0	3-6
	24	5-6	6-6	5-0	6-0	4-0	4-6	2-6	3-0
	32	5-0	6-0	4-6	5-0	3-6	4-0	2-0	2-6
2 x 6	12	13-0	16-6	12-0	14-0	10-6	11-6	7-0	8-6
	16	11-6	14-6	10-6	12-0	8-6	10-0	6-0	7-6
	24	10-0	12-0	8-6	10-0	7-0	8-6	5-0	6-0
	32	8-6	10-6	7-6	9-0	6-0	7-6	4-6	5-6
2 x 8	12	17-0	21-6	16-0	19-0	13-6	16-0	10-6	12-6
	16	15-6	19-0	14-0	16-6	12-0	14-0	9-0	11-0
	24	13-6	15-6	11-6	13-6	10-0	11-6	7-6	9-0
	32	11-6	13-6	10-0	12-0	8-6	10-0	6-6	8-0
2 x 10	12	21-6	27-0	20-0	25-0	17-6	20-6	14-0	16-0
	16	19-6	23-6	18-6	22-0	15-6	18-0	12-0	14-0
	24	16-6	19-6	15-6	18-0	13-0	15-0	10-0	12-0
	32	14-6	17-0	13-6	16-0	11-0	13-0	9-0	10-6

¹See footnotes on page 198.

TABLE NO. 25-T—ALLOWABLE SPANS FOR ROOF RAFTERS USING NONSTRESS-GRADED LUMBER¹—(Continued)

SIZE OF ROOF RAFTERS (Inches)	SPACING OF ROOF RAFTERS (Inches)	MAXIMUM ALLOWABLE SPAN (Feet and Inches Measured Along the Horizontal Projection)							
		GROUP I		GROUP II		GROUP III		GROUP IV ²	
		Supporting Ceiling	Not Supporting Ceiling	Supporting Ceiling	Not Supporting Ceiling	Supporting Ceiling	Not Supporting Ceiling	Supporting Ceiling	Not Supporting Ceiling
2 x 12	12	25-6	32-0	24-0	31-0	22-6	26-6	17-6	20-6
	16	23-6	28-0	22-0	27-6	22-0	23-6	15-6	18-0
	24	20-0	23-6	19-6	23-0	16-6	19-6	13-0	15-0
	32	17-6	20-6	17-0	20-0	14-6	17-0	11-0	13-0
DESIGN LOADING AND DEFLECTION CRITERIA:									
Live load—20 pounds per square foot on the horizontal projection. Dead load weight of roof—seven pounds per square foot on the horizontal projection—plus weight of rafters. Eleven pounds per square foot on the horizontal projection—weight of lath and plaster ceiling; Deflection—With plastered ceiling—not to exceed 1/360 of the span with live load nor 1/240 of the span with dead and live load—Without plastered ceiling—not considered.									

¹Species of lumber are divided into groups as set forth in Table No. 25-G. Allowable stresses are increased 25 per cent for roof loading [Section 2504 (e) 2]. Span lengths for stress-graded lumber set forth in Table No. 25-A may be based on the stresses therein. Spans in Group I are suitable for any species of stress-graded lumber in Table No. 25-A which has a modulus of elasticity of 1,600,000 pounds per square inch and an allowable extreme fiber stress in bending of 1100 pounds per square inch. The allowable spans are based upon stress and deflection criteria set forth in U.B.C. Standard No. 25-21-64.

²Lumber in Group IV may be used only under conditions specifically approved by the Building Official.

eighths-inch ($\frac{3}{8}$ ") plywood shall be applied with the face grain at right angles to the span of the planks.

(c) **Plywood Subflooring.** Where used as structural subflooring, plywood shall be of the minimum thicknesses set forth in Table No. 25-O.

(f) **Plywood Roof Sheathing.** Where used as structural roof sheathing, plywood shall be of the minimum thicknesses set forth in Table No. 25-P.

**Light Frame
Construction
(Continued)**

Sec. 2516. Wood stud walls sheathed with fiberboard sheathing complying with Section 2202 may be used to resist horizontal forces not exceeding those set forth in Table No. 25-V. The fiberboard sheathing, four feet by eight feet (4' x 8'), shall be applied vertically to wood studs not less than one and five-eighths inches ($1\frac{5}{8}$ ") in width, spaced sixteen inches (16") on centers. Nailing shown in Table No. 25-V shall be provided at the perimeter of the sheathing board, and at intermediate studs. Blocking not less than one and five-eighths inches ($1\frac{5}{8}$ ") in width shall be provided at horizontal joints when wall height exceeds length of sheathing panel and nail

**Fiberboard
Sheathing
Diaphragms**

TABLE NO. 25-U—ALLOWABLE SPANS FOR TWO-INCH (2") TONGUE AND GROOVE PLANKING USING NONSTRESS-GRADED LUMBER

GROUP	MAXIMUM ALLOWABLE SPAN ^{1,2} (Feet and Inches Measured Along the Horizontal Projection)		
	FLOOR PLANKING With or Without Finish Flooring	ROOF PLANKING	
		Supporting Finish Ceiling	No Finish Ceiling
I	4'6"	7'6"	9'0"
II	4'6"	7'0"	8'6"
III	4'6"	6'6"	8'0"
IV ³	4'6"	5'6"	6'0"
DESIGN LOADING AND DEFLECTION CRITERIA:			
Floor: Live Load—40 pounds per square foot. Dead Load—weight of planking and finish flooring seven pounds per square foot. Weight of lath and plaster ceiling eight pounds per square foot. The allowable spans for Groups I, II and III have been reduced to values shown based upon practical field problems and experience.			
Roof: Live Load—20 pounds per square foot. Dead Load—weight of planking and roofing 10 pounds per square foot. Weight of lath and plaster ceiling eight pounds per square foot.			
Deflection: See Table No. 23-D.			

¹For planking placed diagonally across supports spans shall be measured along the planking. See U.B.C. Standard No. 25-21-64 for criteria used in developing table. For live load of 50 pounds per square foot on floor planking spans shall be reduced to 90 per cent of tabulated values.

²Spans are based on a net thickness of one and one-half inches ($1\frac{1}{2}$ "). Spans for planking of one and five-eighths-inch ($1\frac{5}{8}$ ") net thickness may be increased by six inches (6").

³Lumber in Group IV may be used only under conditions specifically approved by the Building Official.

**Fiberboard
Sheathing
Diaphragms
(Continued)**

sheathing with nails shown in Table No. 25-V spaced three inches (3") on centers each side of joint. Nails shall be spaced not less than three-eighths inch ($\frac{3}{8}$ ") from edges and ends of sheathing.

Marginal studs of shear walls or shear-resisting elements shall be adequately anchored at top and bottom and designed to resist all forces. The maximum height-width ratio shall be one and one-half to one.

**Foundation
Ventilation,
Durability,
and Termite
Protection**

Sec. 2517. (a) Foundation Ventilation. The space between the bottom of floor joists and the ground of any building (except such space as is occupied by a basement or cellar) shall be provided with a sufficient number of ventilating openings through foundation walls or exterior walls to insure ample ventilation, and such openings shall be covered with a corrosion-resistant wire mesh not greater than one-half inch ($\frac{1}{2}$ ") nor less than one-fourth inch ($\frac{1}{4}$ ") in any dimension. The minimum total area of ventilating openings shall be proportioned on the basis of two square feet (2 sq. ft.) for each twenty-five linear feet (25 lin. ft.) or major fraction thereof of exterior wall. One such ventilating opening shall be within three feet (3') of each corner of said building. Such openings need not be placed in the front of the building.

Minimum clearance between bottom of floor joist or bottom of floors without joists and the ground beneath shall be eighteen inches (18"). Minimum clearance under girders shall be twelve inches (12").

(b) Durability. Where not otherwise prohibited by other provisions of this Code, no wood, other than Foundation Grade redwood, Foundation Grade cedar, all heartwood cypress, or any species of wood, pressure-treated with an approved preservative, all marked or branded by an approved agency, shall be nearer than six inches (6") to any earth unless separated by concrete at least three inches (3") thick, except that untreated wood may be used where entirely below ground-water level or continuously submerged in fresh water, and untreated wood may be used in fences and similar

**TABLE NO. 25-V—ALLOWABLE SHEARS FOR WIND OR SEISMIC LOADING
ON VERTICAL DIAPHRAGMS OF FIBERBOARD SHEATHING BOARD
CONSTRUCTION FOR TYPE V CONSTRUCTION ONLY¹**

SIZE AND APPLICATION	NAIL SIZE	SHEAR VALUE 3" NAIL SPACING AROUND PERIMETER AND 6" AT INTERMEDIATE SUPPORTS
7 $\frac{1}{2}$ " x 4' x 8'	11 ga. gal. roofing nail 1 $\frac{1}{2}$ " long, $\frac{3}{16}$ " head	125
5 $\frac{5}{8}$ " x 4' x 8'	11 ga. gal. roofing nail 1 $\frac{3}{4}$ " long, $\frac{7}{16}$ " head	175

¹Fiberboard sheathing diaphragms shall not be used to brace concrete or masonry walls.

well-ventilated and accessible nonload-bearing structures where not actually in direct contact with earth.

(c) **Termite Protection.** All foundation plates or sills and sleepers on a concrete or masonry slab which is in direct contact with earth and sills which rest on concrete or masonry foundations shall be any species or grade of wood specified in Section 2504 (b) pressure-treated with an approved preservative or Foundation Grade redwood, all marked or branded by an approved agency. Foundation Grade cedar, marked or branded by an approved agency may be used for sills in territories subject to moderate hazard, where termite damage is not frequent and when specifically approved by the Building Official. In territories where hazard of termite damage is slight, any species of wood specified in Section 2504 (b) may be used for sills when specifically approved by the Building Official.

Before any new building is erected all stumps and roots shall be removed from the soil to a depth of at least twelve inches (12") below the surface of the ground in the area to be occupied by the building.

All wood forms which have been used in placing concrete, if within the ground or between foundation sills and the ground shall be removed before a building is occupied or used for any purpose. Before completion loose or casual wood shall be removed from direct contact with the ground under the building.

Not less than four inches (4") of solid masonry or three inches (3") of concrete shall be provided between planter boxes and wood stud walls. The masonry or concrete shall extend to a height not less than six inches (6") above the outer wall of the planter. Solid sheathing and 15-pound building paper shall be installed between the masonry or concrete and the wood stud.

**Foundation
Ventilation,
Durability,
and Termite
Protection
(Continued)**

CHAPTER 26—CONCRETE

Quality

Sec. 2601. The quality of the materials used in concrete and the quality of concrete shall conform to the physical and chemical properties as specified in Sections 2604, 2605, and 2606, and to the following standards:

MATERIALS	U.B.C. DESIGNATION
PORTLAND CEMENT	
Portland Cement.....	26- 1-64
Air-entraining Portland Cement.....	24-14-64
Portland Blast Furnace Slag Cement.....	26- 2-64
Portland Pozzolan Cement.....	26- 3-64
AGGREGATES	
Concrete	26- 4-64
Lightweight, for Structural and Insulating Concrete	26- 5-64
METAL REINFORCEMENT	
Steel Bars.....	26- 6-64
Prestressed Steel Strand.....	26- 7-64
Prestressed Steel Wire.....	26- 8-64
ADMIXTURES	
Air-entraining Admixtures.....	26- 9-64
CONCRETE COMPRESSION AND FLEXURE TEST SPECIMENS	
Making and Curing—in the Field.....	26-10-64
Test for Compressive Strength.....	26-10-64
Making and Curing—in the Laboratory.....	26-10-64
READY-MIXED CONCRETE	26-11-64
DESIGN	
Ultimate Strength	26-12-64
Prestressed	26-13-64
Fire Resistance.....	43- 1-64
Slabs	26-14-64

Particular attention in design shall be given to properties of individual materials used in prestressed concrete and their effect on compressive strength, modulus of elasticity, drying, shrinkage, creep, bond strength, and uniformity of concrete cast-in-place.

Design

Sec. 2602. The design of structures in concrete of cast-in-place or precast construction, plain, reinforced or prestressed shall conform to the rules and principles specified in this Chapter.

Definitions

Sec. 2603. The following definitions give the meaning of certain terms as used in this Chapter:

ADMIXTURE is a material other than water, aggregate or portland cement that is used as an ingredient of concrete and is added to the batch immediately before or during mixing.

AGGREGATE, inert material which is mixed with portland cement and water to produce concrete.

Definitions
(Continued)

BAR—DEFORMED, a reinforcing bar conforming to U.B.C. Standards. Except as specified in Section 2616, wire mesh with welded intersections not farther apart than six inches (6") in the direction of the principal reinforcement and with cross wires not smaller than No. 10 U. S. gauge may be rated as a deformed bar.

BAR—PLAIN, reinforcement which does not conform to the definition of deformed bar shall be classed as a plain bar.

CAST-IN-PLACE CONSTRUCTION is construction whereby concrete is deposited in its final position.

CEMENT—PORTLAND, is the product obtained by finely pulverizing clinker consisting essentially of hydraulic calcium silicates, to which no additions have been made subsequent to calcination other than water or untreated calcium sulfate, except that additions not to exceed one per cent of other materials may be interground with the clinker at the option of the manufacturer, provided such materials in the amounts indicated have been shown to be not harmful by tests.

COLUMN, an upright compression member the length of which exceeds three times its least lateral dimension.

CONCRETE, a mixture of portland cement, fine aggregate, coarse aggregate, and water.

CONCRETE—EFFECTIVE AREA OF, the area of a section which lies between the centroid of the tensile reinforcement and the compression face of a flexural member.

CONCRETE—PLAIN, concrete without metal reinforcement, or reinforced only for shrinkage or temperature changes.

CONCRETE—PNEUMATICALLY PLACED, a mixture of fine aggregate and cement pneumatically applied by suitable mechanism, and to which water is added immediately prior to discharge from the applicator. It shall be considered as concrete for particulars of design as specified in this Chapter.

CONCRETE—REINFORCED, concrete in which metal other than that provided for shrinkage or temperature changes is embedded in such a manner that the two materials act together in resisting forces.

LAITANCE, extremely fine material of little or no hardness which may collect on the surface of freshly deposited concrete or mortar, resulting from the use of excess mixing water and usually recognized by its relatively light color.

Definitions
(Continued)

MORTAR, a mixture of portland cement, fine aggregate, and water.

PEDESTAL, an upright compression member whose height does not exceed three times its least lateral dimension.

PRECAST CONSTRUCTION is construction whereby concrete members are cast in a place prepared for this purpose, to be moved to their final position.

PRESTRESSED CONCRETE CONSTRUCTION is construction of concrete members, cast-in-place or precast, in which controlled forces create controlled internal stresses.

The following terms are used in this Chapter in application of provisions governing prestressed concrete:

Tendons are steel members which generally are used to exert the prestressing force onto the concrete.

Transfer is the act of application of the prestressing force to the concrete.

Pretensioning is the system of prestressing concrete members whereby tendons are stressed prior to pouring of the concrete and the prestressing force is transmitted to the concrete by bond.

Post-tensioning is the system of prestressing concrete members whereby tendons are stressed after the concrete has obtained a required strength and the prestressing force is transmitted to the concrete generally by anchoring the stressed tendons to the member.

Losses: Gradual losses are the reduction from the initial force to the working force and are due to shrinkage, creep of the concrete and relaxation of the steel.

Elastic shortening losses are due to the elastic deformation of the concrete at the time of transfer.

Tensioning losses are those incurred in post-tensioned concrete at the time of stressing and anchoring the tendons, which are due to tendon friction and anchorage set and vary with the system used.

Forces: Jacking force is the force exerted by the ram on the tendon.

Initial force is the force left in the tendon immediately after transferring the prestressing force to the concrete.

Working force is the final force left in the tendons after all losses have occurred.

PRESTRESSING FORCE is the force which is designed and controlled to create the required internal stresses.

REINFORCEMENT—EFFECTIVE AREA, the area obtained by multiplying the right cross-sectional area of the metal reinforcement by the cosine of the angle between its direction and that for which the effectiveness of the reinforcement is to be determined.

REINFORCEMENT—NEGATIVE, reinforcement so placed as to take tensile stress due to negative bending moment. **Definitions (Continued)**

REINFORCEMENT—POSITIVE, reinforcement so placed as to take tensile stress due to positive bending moment.

REINFORCEMENT—RATIO OF, the ratio of the effective area of the reinforcement cut by a section of a member to the effective area of the concrete at that section.

SURFACE WATER, the water carried by the aggregate except that held by absorption within the aggregate particles themselves.

Sec. 2604. (a) Portland Cement. Portland cement shall conform to U.B.C. Standards No. 26-1-64, 26-2-64, 26-3-64, or 24-14-64. **Materials**

(b) **Concrete Aggregates.** Concrete aggregates, except lightweight aggregates, shall conform to U.B.C. Standard No. 26-4-64, including the methods of sampling and testing.

Lightweight aggregates for concrete shall conform to U.B.C. Standard No. 26-5-64, including the methods of sampling and testing.

Lightweight aggregates for insulating concrete shall conform to U.B.C. Standard No. 26-5-64.

Aggregates that do not meet the above specifications but that have been shown by test or actual service to produce concrete of the required strength, durability, watertightness, and wearing qualities, may be used under the provisions of Section 2606, Method 2, where authorized by the Building Official.

The maximum size of the aggregate shall be not larger than one-fifth of the narrowest dimension between forms of the member for which the concrete is to be used nor larger than three-fourths of the minimum clear spacing between reinforcing bars.

(c) **Water.** Water used in mixing concrete shall be clean and free from injurious amounts of oil, acid, alkali, organic matter, or other harmful substances. Sea water shall not be used in construction of concrete members.

(d) **Metal Reinforcement.** Metal reinforcement shall conform to the requirements set forth in U.B.C. Standard No. 26-6-64. Deformations on deformed bars shall conform to the requirements set forth in U.B.C. Standard No. 26-6-64.

All reinforcement bars lacking grade identification marks shall on delivery be accompanied by a manufacturer's guarantee of grade which will identify variations.

(e) **Prestressing Steel.** Prestressing steel shall conform to the requirements set forth in U.B.C. Standards No. 26-7-64, and No. 26-8-64.

Materials
(Continued)

(f) **Storage.** Cement and aggregates shall be stored in a manner to prevent deterioration or the intrusion of foreign matter. Any material which has deteriorated or which has been damaged shall not be used for concrete.

(g) **Admixtures.** Air-entraining to concrete shall conform to U.B.C. Standard No. 26-9-64. Provision shall be made to assure that no contact exists between prestressed steel and concrete in which an admixture containing calcium chloride has been used.

Tests

Sec. 2605. On concrete work the Building Official shall have the right to require the owner or his agent to make tests of the concrete and other materials from time to time to determine whether the materials and methods in use are such as to produce concrete or reinforced concrete of the quality specified and used in the design of the building or structure. The tests shall be made, when ordered by the Building Official, by the owner or his authorized representative and no responsibility for the expense of these tests shall attach to the Building Department. All such tests shall be made by an approved agency, and copies of the results shall be kept on file in the office of the Building Official for a period of not less than two years after the acceptance of the structure. Specimens for concrete cylinder tests shall be taken at the place where the concrete is being deposited and shall be taken and cured in accordance with the requirements set forth in U.B.C. Standard No. 26-10-64 and tested in accordance with the requirements set forth in U.B.C. Standard No. 26-10-64. Test cylinders of pneumatically placed concrete shall be made in a manner that will permit the blast of air to compact firmly the materials and provide proper escapement of the air to eliminate possible back pressure, and such cylinders shall be cured and tested as specified above.

The Building Official shall have the right to order the test under load of any portion of a completed structure, when the conditions have been such as to leave reasonable doubt as to the adequacy of the structure to serve the purpose for which it is intended.

When a load test is required, the member or portion of the structure under consideration shall be subject to a superimposed load equal to one and one-half times the live load plus one-half of the dead load. This load shall be left in position for a period of 24 hours before removal. If, during the test, or upon removal of the load, the member or portion of the structure shows evident failure, such changes or modifications as are necessary to make the structure adequate for the rated capacity shall be made; or, where lawful, a lower rating shall be established. The structure shall be considered to have passed the test if the maximum deflection at the end of the 24-hour period does not exceed the value of "D" as given by Formula (1):

$$D = \frac{.001 L^3}{12t} \dots\dots\dots (1) \quad \text{Tests (Continued)}$$

WHERE:

L is the span, t is the total depth of the slab or beam and D is the maximum deflection—all expressed in the same units.

If the deflection exceeds the value of “ D ” as given in Formula (1), the construction shall be considered to have passed the test if within 24 hours after the removal of the load the slabs or beams show a recovery of at least 75 per cent of the observed deflection.

Sec. 2606. For the design of concrete structures, the value of “ f_c ” used for determining the working stresses as specified in Section 2614 shall be based on the specified minimum ultimate 28-day compressive strength of the concrete, or on the specified minimum ultimate compressive strength at the earlier age at which the concrete may be expected to receive its full load. All plans submitted for approval or used on the job shall clearly show the assumed strength of concrete at a specified age for which all parts of the structure were designed.

Quality of Concrete

Concrete without air-entrainment which will be exposed to the action of freezing weather shall have a water content not greater than six gallons per sack of cement.

The determination of the proportions of cement, aggregate, and water to attain the required strengths shall be made by one of the following methods:

Method 1—Concrete Made from Average Materials. When no preliminary tests of the materials to be used are made, the water content per sack of cement shall not exceed the values set forth in Table No. 26-A. Method 2 shall be employed when strengths in excess of 4000 pounds per square inch are required or when lightweight aggregates are used or when any admixture not conforming to U.B.C. Standard No. 26-9-64 for air-entraining admixtures is used.

Method 2—Controlled Concrete. Water contents other than those set forth in Table No. 26-A may be used provided that the strength-quality of the materials proposed for use in the structure shall be established by tests which shall be made in advance of the beginning of operations, using the consistencies suitable for the work and in accordance with U.B.C. Standard No. 26-10-64. A curve representing the relation between the water-content and the average 28-day compressive strength, or earlier strength at which the concrete is to receive its full working load, shall be established for a range of values including all the compressive strengths called for on the plans. The curve shall be established by at least three points, each point representing average values from at least four test speci-

**Quality of
Concrete
(Continued)**

mens. The water-content used in the concrete for the structure, as determined from the curve, shall correspond to a strength which is 15 per cent greater than that called for on the plans. No substitutions shall be made in the materials used on the work without additional tests in accordance herewith to show that the quality of the concrete is satisfactory.

**Proportions
and
Consistency**

Sec. 2607. The proportions of aggregate to cement for any concrete shall be such as to produce a mixture which will work readily into the corners and angles of the forms and around reinforcement with the method of placing employed on the work, but without permitting the materials to segregate or excess free water to collect on the surface. The combined aggregates shall be of such composition of sizes that when separated on the No. 4 standard sieve, the weight passing the sieve (fine aggregate) shall be not less than 30 per cent nor greater than 50 per cent of the total unless otherwise required by the Building Official, except that these proportions do not necessarily apply to lightweight aggregates.

Measurement of materials for ready-mixed concrete shall conform to U.B.C. Standard No. 26-11-64.

Admixtures of lime or finely pulverized inert materials may be added but not in excess of six per cent by volume of the cement used.

**Control of
Proportions**

Sec. 2608. The methods of measuring concrete materials shall be such that the proportions of all materials can be accurately controlled during the progress of the work and easily checked at any time by the Building Official or his authorized representative. A tolerance of one-fourth gallon of water per sack of cement in any batch of concrete will be allowed, provided that the average for any 10 consecutive batches does not show a water content greater than that set forth in Table No. 26-A, and on plans as specified in Section 2606.

TABLE NO. 26-A—ASSUMED STRENGTH OF CONCRETE MIXTURES¹

MAXIMUM PERMISSIBLE WATER-CEMENT RATIO U. S. GALLONS PER 94-LB. SACK OF CEMENT ²		SPECIFIED MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS, P.S.I.
NONAIR-ENTRAINED CONCRETE	AIR-ENTRAINED CONCRETE	
7½	7	2000
7¼	6¾	2500 ³
6½	5¾	3000 ³
5¾	4½	3500 ³
5	4	4000 ³

¹Concrete and grout used in prestressed concrete shall be a mix designed specifically to meet all requirements.

²Including free surface moisture on aggregates.

³Special inspection required. See Section 305.

The method of delivering the aggregates to the work and of storing and handling shall be such that the moisture content of the aggregates as they come to the mixer shall not be subject to frequent or unnecessary changes.

**Control of
Proportions
(Continued)**

Sec. 2609. (a) Mixing. The concrete shall be mixed until there is a uniform distribution of the materials and the mass is uniform in color and homogeneous. In machine mixing, only batch mixers shall be used. Each batch shall be mixed not less than one minute after all the materials are in the mixer and must be discharged completely before the mixer is recharged. Machine mixers shall have a peripheral speed of approximately two hundred feet (200') per minute.

**Mixing and
Placing
Concrete**

Ready-mixed concrete shall be mixed and delivered in accordance with the requirements set forth in U.B.C. Standard No. 26-11-64.

(b) Cleaning Forms and Equipment. Before concrete is placed all equipment for mixing and transporting the concrete shall be cleaned, all debris shall be removed from the spaces to be occupied by the concrete, forms shall be thoroughly wetted (except in freezing weather) or oiled, and masonry that will be in contact with concrete shall be well drenched (except in freezing weather). Reinforcement shall be thoroughly cleaned and secured in position. Concrete shall not be placed until the forms and reinforcement have been inspected and approved by the Building Official.

(c) Removal of Water from Excavations. Water shall be removed from excavations before concrete is deposited, unless otherwise directed by the Building Official. Any flow of water into an excavation shall be diverted through proper side drains to a sump, or be removed by other approved methods which will avoid washing the freshly deposited concrete. Water vent pipes and drains shall be filled by grouting or otherwise, after the concrete has hardened thoroughly.

(d) Transporting Concrete. Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods which shall prevent the separation or loss of the ingredients. It shall be deposited as nearly as practicable in its final position to avoid rehandling or flowing. Under no circumstances shall concrete that has attained its initial set be used.

Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to insure a practically continuous flow of concrete at the delivery end without separation of the materials.

(e) Placing. Concrete shall be thoroughly compacted with suitable tools. When necessary, openings shall be provided in the forms to permit the placing of concrete in such a manner as to avoid accumulations of hardened concrete on the forms or reinforcing bars. The concrete shall be thoroughly worked around the reinforcement.

**Mixing and
Placing
Concrete
(Continued)**

(f) **Curing.** Exposed surfaces of concrete shall be kept moist, for a period of at least seven days after being deposited for ordinary cement, and three days for high-early-strength cement. This period may be reduced if high-temperature curing is applied. High-temperature curing shall conform to latest practice. The rate of heating and cooling shall be controlled so as to prevent thermal shock to the concrete. During high-temperature curing the concrete shall be protected from rain and the rapid loss of moisture prior to the curing period. Curing shall be continued until the required strength for transfer is reached. Rapid drying should be prevented, where it will tend to produce undesirable cracks.

(g) **Depositing in Cold Weather.** Adequate equipment shall be provided for heating the concrete materials and protecting the concrete during freezing or near-freezing weather. No frozen materials or materials containing ice shall be used.

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

(h) **Bonding Fresh and Hardened Concrete.** Before new concrete is deposited on or against concrete which has set, the forms shall be retightened, the surface of the set concrete shall be roughened, cleaned of foreign matter and laitance, and thoroughly wetted but not saturated. The clean and wetted surfaces of the hardened concrete, including vertical and inclined surfaces, shall be slushed with a coating of neat cement grout against which the new concrete shall be placed before the grout has attained its set. For walls and columns the grout may be omitted on the horizontal surfaces, but a layer of mortar having the composition of the mortar in the concrete shall be placed before resuming concreting.

**Forms and
Details of
Construction**

Sec. 2610. (a) Design of Forms. Forms shall conform to the shape, lines, and dimensions of the member as called for on the plans and shall be substantial and sufficiently tight to prevent leakage of mortar. They shall be properly braced or tied together so as to maintain position and shape. If adequate foundation for shores cannot be secured, trussed supports shall be provided. Forms for prestressed concrete

members shall be designed and constructed to permit movement and deflection which take place when the prestressing force is transferred to the concrete.

Temporary openings shall be provided at the base of column and wall forms; and at other points where necessary, to facilitate cleaning and inspection.

(b) **Removal of Forms.** Forms shall not be disturbed until the concrete has hardened sufficiently to permit their removal with safety. Shoring shall not be removed until the member has acquired sufficient strength to support safely its own weight and the load upon it. Members subject to additional loads during construction shall be adequately shored to support both the member and construction loads in a manner that will protect the member from damage.

The Building Official may require forms to remain in place for a specified time.

(c) **Cleaning and Bending Reinforcement.** Metal reinforcement, at the time concrete is placed, shall be free from rust, scale, or other coatings that will destroy or reduce the bond. Bends for stirrups and ties shall be made around a pin having a diameter not less than two times the minimum thickness of the bar. Bends for other bars, except hooks, shall be made around a pin having a diameter not less than six times the minimum thickness of the bar, except that for bars larger than one inch (1"), the pin shall be not less than eight times the minimum thickness of the bar. All bars shall be bent cold.

(d) **Placing Reinforcement.** Metal reinforcement shall be accurately placed and secured and shall be supported by chairs, spacers, or hangers. The minimum clear distance between parallel bars, except in columns, shall be equal to the nominal diameter of the bars. The minimum clear distance between bars and forms shall be the diameter of round bars and one and one-half times the side dimension of square bars. The clear distance between bars shall be not less than one inch (1") or less than one and one-third times the maximum size of the coarse aggregate. Bars shall be embedded a distance from any face of any member not less than the minimum distance as specified in Section 4303.

When wire or other reinforcement not exceeding one-fourth inch ($\frac{1}{4}$ ") in diameter is used as reinforcement for slabs not exceeding ten feet (10') in span, the reinforcement may be curved from a point near the top of the slab over the support to a point near the bottom of the slab at mid-span, provided such reinforcement is either continuous over, or securely anchored to the support.

(c) **Splices and Offsets in Reinforcement.** In slabs, beams, and girders, splices of reinforcement shall not be made at points of maximum stress without the approval of the Building Official. Splices, where permitted, shall provide sufficient

**Forms and
Details of
Construction
(Continued)**

**Forms and
Details of
Construction
(Continued)**

lap to transfer the stress between bars by bond and shear. In such splices the bars shall be in contact and wired together and the minimum distance specified in Subsection (d) of this Section shall be maintained between bars or between wired splices and adjacent bars or splices.

Where changes in the cross section of a column occur, the longitudinal bars shall be offset in a region where lateral support is afforded. Where offset, the slope of the inclined portion shall be not more than one in six, and in the case of tied columns the ties shall be spaced not over three inches (3") on center for a distance of one foot (1') below the actual point of offset.

(f) Protective Covering of Concrete. At the underside of footings metal reinforcement shall have a minimum covering of three inches (3") of concrete.

In fire-resistive construction, metal reinforcement shall be protected as specified in Section 4303.

Exposed reinforcement bars intended for bonding with future extensions shall be protected from corrosion.

(g) Construction Joints. Joints not indicated on the plans shall be so made and located as least to impair the strength of the completed structure. Where a joint is to be made, any excess water and laitance shall be removed from the surface after concrete is deposited. Before depositing of concrete is resumed the hardened surface shall be treated as specified in Section 2609 (h).

At least two hours must elapse after concrete is deposited in the columns or walls before depositing in beams, girders, or slabs supported thereon. Haunches and column capitals shall be considered as part of, and to act continuous with, the floor.

Construction joints in floors shall be located near the middle of the spans of slabs, beams, or girders, unless a beam intersects a girder at this point, in which case the joints in the girders shall be offset a distance equal to twice the width of the beam. In this last case, provision shall be made for shear by use of inclined reinforcement.

(h) Embedment of Pipes. Electric conduits and other pipes whose embedment is allowed shall not, with their fittings, displace that concrete of a column on which stress is calculated or which is required for fire protection, to greater extent than four per cent of the area of the cross section. Sleeves or other pipes passing through floors, walls, or beams shall not be of such size or in such location as to impair unduly the strength of the construction; such sleeves or pipes may be considered as replacing structurally the displaced concrete, provided they are not exposed to rusting or other deterioration, are of uncoated iron or steel not thinner than standard steel pipe, have a nominal inside diameter not over two inches (2"), and are spaced not less than three diameters on centers. Except when plans of conduits and pipes are

approved by the Building Official, embedded pipes or conduits, other than those merely passing through, shall not be larger in outside diameter than one-third the thickness of the slab, wall, or beam in which they are embedded, nor shall they be placed closer than three diameters on center, nor so located as to impair unduly the strength of the construction. Circular uncoated or galvanized electric conduit of iron or steel may be considered as replacing the displaced concrete.

No chase, sleeve, or pipe shall intercept a structural member unless such member is specifically designed therefor.

Sec. 2611. (a) Design Methods. The design of reinforced concrete members shall be made with reference to allowable stresses, working loads and the accepted straight-line theory of flexure, except as specified in Subsections 2611 (b) and (c). The following assumptions shall be made:

1. The steel takes all the tensile stress.
2. In determining the ratio " n " for design purposes, the modulus of elasticity for the concrete shall be assumed as 1000 f_c , and that for steel as 30,000,000 pounds per square inch.

(b) Ultimate Strength Method. The ultimate strength method of design may be used for the design of reinforced concrete members as set forth in U.B.C. Standard No. 26-12-64.

(c) Prestressed Concrete Design. Assumptions for design of prestressed concrete members shall be as set forth in U.B.C. Standard No. 26-13-64.

Sec. 2612. Concrete shall not be supported by wood members except as provided for in Section 2510.

Sec. 2613. (a) General. Reinforced concrete members, designed as specified in Subsections 2611 (a) and (b), shall have the minimum thicknesses and protection of metal reinforcement specified in Chapter 43.

(b) Prestressed Concrete. For the purpose of determining the degree of fire resistance, prestressed concrete construction shall be tested as set forth in U.B.C. Standard No. 43-1-64.

Sec. 2614. The symbols and notations used in these regulations are defined as follows:

- α = Angle between inclined web bars and axis of beam.
- A_v = Total area of web reinforcement in tension within a distance of " s ," or the total area of all bars bent up in any one plane.
- b = Width of rectangular section or width of flange of I- or T-sections.
- b' = Width of web of I- or T-sections.
- C = Ratio of permissible concrete fiber stress in axially loaded column to permissible fiber stress in flexure.

**Forms and
Details of
Construction
(Continued)**

**Assumptions
for Design**

Wood

**Fire
Resistance**

**Symbols and
Notations**

**Symbols and
Notations
(Continued)**

- d = Depth from compression face of beam or slab to centroid of longitudinal tensile reinforcement.
- e = Eccentricity of the resultant load on a column, measured from the gravity axis.
- E_c = Modulus of elasticity of concrete in compression.
- E_s = Modulus of elasticity of steel in tension or compression (30,000,000 pounds per square inch).
- f_c = Compressive unit stress in extreme fiber of concrete in flexure.
- f'_c = Ultimate compressive strength of concrete, *usually* at age of 28 days. (See Section 2604.)
- f_w = Tensile unit stress in web reinforcement.
- I = Moment of inertia of a section about the neutral axis for bending.
- j = Ratio of distance between centroid of compression and centroid of tension to the depth " d ."
- n = Ratio of modulus of elasticity of steel to that of concrete = $\frac{E_s}{E_c}$
- R = Least radius of gyration of a section.
- Σ_o = Sum of perimeters of bars in one set.
- s = Spacing of stirrups or of bent bars in a direction parallel to that of the main reinforcement.
- t_1 = Thickness of flat slab without drop panels, or the thickness of flat slab through the drop panels where such are used.
- t_2 = Thickness of flat slab (with drop panels) at points outside the drop panel.
- u = Bond stress per unit of surface area of bar.
- v = Shearing unit stress.
- v_a = Unit shearing stress permitted on the concrete of the web.
- V = Total shear.
- V' = Total shear carried by the web reinforcement.
- w = Uniformly distributed load per unit of length of beam or per unit area of slab.

**Allowable
Unit Stresses
in Reinforcement**

Sec. 2615. The unit stresses in pounds per square inch on concrete to be used in the design shall not exceed the values set forth in Table No. 26-B where " f'_c " equals the minimum ultimate compressive strength at 28 days, or at the earlier age at which the concrete may be expected to receive its full load.

The following unit stresses in reinforcing steel shall not be exceeded:

In Tension:

Intermediate- and hard-grade billet or axle steel, rail steel and cold-drawn wire.....	20,000 p.s.i.
Structural grade bars and structural steel shapes	18,000 p.s.i.
For one-way slabs not exceeding twelve feet (12') in span, steel reinforcement not exceeding three-eighths inch ($\frac{3}{8}$ ") in diameter, 50 per cent of the minimum yield point specified in the U.B.C. Standards for the particular kind and grade of steel used, but in no case to exceed.....	30,000 p.s.i.

**Allowable
Unit Stresses
in Reinforcement
(Continued)**

In Compression:

Structural steel section in composite columns	16,000 p.s.i.
Cast iron section in composite columns.....	10,000 p.s.i.

Sec. 2616. (a) Design. All members shall be designed to resist at all sections the maximum bending moments and shears produced by dead load, live load, and other loads, as determined by the principle of continuity. In the case of approximately equal spans with loads uniformly distributed, where the intensity of live load does not exceed three times the intensity of dead load, this is satisfied essentially by the following values:

**Flexural
Computations**

Negative moment at face of first interior support:

For beams and girders and for slabs exceeding ten feet (10'):

$$\text{Two spans} \quad \frac{1}{8} w l^2$$

$$\text{More than two spans} \quad \frac{1}{10} w l^2$$

For slabs not exceeding ten feet (10') in span:

$$\text{Two spans} \quad \frac{1}{10} w l^2$$

$$\text{More than two spans} \quad \frac{1}{12} w l^2$$

Negative moment at face of other interior supports:

$$\frac{1}{12} w l^2$$

Positive moment at center of span:

$$\text{End spans} \quad \frac{1}{10} w l^2$$

TABLE NO. 26-B—ALLOWABLE UNIT STRESSES IN CONCRETE

DESCRIPTION	ALLOWABLE UNIT STRESSES						
	FOR ANY STRENGTH OF CONCRETE IN ACCORDANCE WITH SEC. 2606 $n = \frac{30,000}{f'_c}$	MAXIMUM VALUE P.S.I.	FOR STRENGTH OF CONCRETE SHOWN BELOW				
			$f'_c = 2000$ P.S.I. $n = 15$	$f'_c = 2500$ P.S.I. $n = 12$	$f'_c = 3000$ P.S.I. $n = 10$	$f'_c = 3750$ P.S.I. $n = 8$	
Flexure: f_c							
Extreme fiber stress in compression.....	f_c	$0.45f'_c$	900	1125	1350	1688	
Extreme fiber stress in tension in plain concrete footings.....	f_c	$0.03f'_c$	60	75	90	113	
Shear: v (as a measure of diagonal tension)							
Beams with no web reinforcement.....	v_c	$0.03f'_c$	90	60	75	90	
Beams with longitudinal bars and with either stirrups or properly located truss bars, but not both.....	v	$0.08f'_c$	240	160	200	240	
Beams with longitudinal bars and a combination of stirrups and truss bars (the latter bent up suitably to carry at least $0.04 f'_c$).....	v	$0.12f'_c$	360	240	300	360	
Flat slabs at distance d from edge of column, capital, or drop panel.....	v_c	$0.03f'_c$	60	75	90	100	
Footings.....	v_c	$0.03f'_c$	75	60	75	75	
Reinforced concrete shear walls.....		$0.05f'_c$	100	125	150	187	
Bond: u							
Deformed bars							
Top bars.....	u	$0.07f'_c$	245	140	175	210	
In 2-way footings (except top bars).....	u	$0.08f'_c$	280	160	200	240	
All others.....	u	$0.10f'_c$	350	200	250	300	
Plain bars (must be hooked)							
Top bars.....	u	$0.03f'_c$	105	60	75	90	
In 2-way footings (except top bars).....	u	$0.036f'_c$	126	72	90	108	
All others.....	u	$0.045f'_c$	158	90	113	135	
Bearing: f_c							
On full area.....	f_c	$0.25f'_c$	500	625	750	938	
On one-third area or less ²	f_c	$0.375f'_c$	750	938	1125	1405	
Pedestals [See Sec. 2623 (e)]							

TABLE NO. 26-B

UNIFORM BUILDING CODE

¹Top bars are horizontal bars so placed that more than twelve inches (12") of concrete are cast in the member below the bar.²This increase shall be permitted only when the least distance between the edges of the loaded and unloaded areas is a minimum of one-fourth of the parallel side dimension of the loaded area. The allowable bearing stress on a reasonably concentric area greater than one-third,

$$\text{Interior spans} \quad \frac{1}{12} w l^2$$

$$\text{Shear in end members at first interior support} \quad 1.20 \frac{w l'}{2}$$

$$\text{Shear at other supports} \quad \frac{w l'}{2}$$

**Flexural
Computations
(Continued)**

For the purpose of applying this method, "approximately" shall be construed to mean that the longer of two adjacent spans shall not exceed the shorter by more than 20 per cent. In these expressions " l " equals the clear span for positive moment and the average of the two adjacent clear spans for negative moment.

(b) **Permissible Assumptions.** The span length of freely supported beams and slabs shall be the clear span plus the depth of beam or slab, but shall not exceed the distance between centers of the supports.

In the application of the principle of continuity, the following assumptions shall be permissible:

1. Consideration may be limited to combinations of dead load on all spans with full live load on two adjacent spans and with full live load on alternate spans.

2. Any reasonable assumption may be adopted for computing the relative stiffness of columns and of floor systems. The assumption made shall be consistent throughout the analysis. In computing the value of " I " for relative stiffness of slabs, beams, girders, and columns, the reinforcement may be neglected. In T-shaped sections allowance shall be made for the effect of flange.

3. The far ends of columns above and below the floor under consideration may be considered fixed.

4. The effect of haunches shall be considered both in determining bending moments and in computing unit stresses.

5. Where slabs of uniform thickness are built integrally with their supports the span length may be taken equal to the clear span between faces of supports and the width of support otherwise neglected.

6. In the application of the principle of continuity, center-to-center distances may be used in the moment determination of all members.

Moments prevailing at the faces of support may be used to proportion the members at these sections.

7. In slabs other than ribbed floor construction or flat slabs, the principal reinforcement shall not be spaced farther apart than three times the slab thickness.

**Flexural
Computations
(Continued)**

8. In structural slabs of uniform thickness the minimum amount of reinforcement in the direction of principal stress shall be

For structural, intermediate and hard grades and rail steel.....	.0025 <i>bd</i>
For steel having a minimum yield point of 56,000 pounds per square inch.....	.002 <i>bd</i>

(c) **Distance between Lateral Supports.** The clear distance between lateral supports of a beam shall not exceed 32 times the least width of compression flange.

(d) **Depth of Beam or Slab.** The depth of the beam or slab shall be taken as the distance from the centroid of the tensile reinforcement to the compression face of the structural member. Any floor finish not placed monolithically with the floor slab shall not be included as a part of the structural member. When the finish is placed monolithically with the structural slab in buildings of the warehouse or industrial class, the over-all depth shall be at least one-half inch ($\frac{1}{2}$ ") over that required by the design of the member.

(e) **Requirements for T-Beams.** Requirements shall be as follows:

1. In T-beam construction the slab and beam shall be built integrally or otherwise effectively bonded together. The effective flange width to be used in the design of symmetrical T-beams shall not exceed one-fourth of the span length of the beam, and its overhanging width on either side of the web shall not exceed eight times the thickness of the slab nor one-half the clear distance to the next beam.

2. For beams having a flange on one side only, the effective overhanging flange width shall not exceed one-twelfth of the span length of the beam, nor six times the thickness of the slab, nor one-half the clear distance to the nearest beam.

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

4. Provisions shall be made for the compressive stress at the support in continuous T-beam construction, care being taken that the provisions of Section 2610 relating to the spacing of bars, and Section 2609 (e) relating to the placing of concrete, shall be fully met.

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

**Flexural
Computations
(Continued)**

6. Isolated beams in which the T-form is used only for the purpose of providing additional compression area, shall have a flange thickness not less than one-half the width of the web and a total flange width not more than four times the web thickness.

(f) **One-way Ribbed Floor Construction.** Construction shall conform to the following requirements:

1. Ribbed floor construction consists of concrete ribs and slabs placed monolithically with or without burned clay or concrete tile fillers. The ribs shall not be farther apart than thirty inches (30") face to face. The ribs shall be straight, not less than four inches (4") wide, nor of a depth more than three times the width.

2. When burned clay or concrete tile fillers, of material having a unit compressive strength at least equal to that of the designed strength of the concrete in the ribs, are used, the shells of the fillers in contact with the ribs may be included in the calculations involving shear or negative bending moment. No other portion of the fillers may be included in the design calculations.

3. The concrete slab over the fillers shall be not less than one and one-half inches ($1\frac{1}{2}$ ") in thickness, nor less in thickness than one-twelfth of the clear distance between ribs. Shrinkage reinforcement in the slab shall be provided as specified in Section 2616.

4. Where removable forms or fillers not complying with paragraph 2 of this Subsection are used, the thickness of the concrete slab shall be not less than one-twelfth of the clear distance between ribs and in no case less than two inches (2"). Such slab shall be reinforced at right angles to the ribs with a minimum of .049 square inches of reinforcing steel per foot of width, and in slabs on which the prescribed live load does not exceed 50 pounds per square foot, no additional reinforcement will be required.

5. When the finish used as a wearing surface is placed monolithically with the structural slab in buildings of the warehouse or industrial class, the thickness of the concrete over the fillers shall be one-half inch ($\frac{1}{2}$ ") greater than the thickness used for design purposes.

6. Where the slab contains conduits or pipes, the thickness shall be not less than one inch (1") plus the total overall depth of such conduits or pipes at any point. Such conduits or pipes shall be so located as not to impair the strength of the construction.

(g) **Compression Steel in Flexural Members.** Compression steel in beams, girders, or slabs shall be anchored by ties or stirrups not less than one-fourth inch ($\frac{1}{4}$ ") in diameter, spaced no farther apart than 16 bar diameters or 48 tie diameters. Such ties or stirrups shall be used throughout the distance where compression steel is required.

**Flexural
Computations
(Continued)**

The effectiveness of compression reinforcement in resisting bending may be taken at twice the value indicated from calculations assuming a straight line relation between stress and strain and the modular ratio given in Section 2611, but not of greater value than the allowable stress in tension.

**Shrinkage and
Temperature
Reinforcement**

Sec. 2617. Reinforcement for shrinkage and temperature stresses normal to the principal reinforcement shall be provided in floor and roof slabs where the principal reinforcement extends in one direction only. Such reinforcement shall provide for the following minimum ratios of reinforcement area to concrete area " bd ," but in no case shall such reinforcing bars be placed farther apart than five times the slab thickness nor more than eighteen inches (18"):

Floor slabs where plain bars are used.....	0.0025
Floor slabs where deformed bars are used.....	.002
Floor slabs where wire fabric is used, having welded intersections not farther apart in the direction of stress than twelve inches (12").....	0.0018
Roof slabs where plain bars are used.....	0.003
Roof slabs where deformed bars are used.....	0.0025
Roof slabs where wire fabric is used, having welded intersections not farther apart in the direction of stress than twelve inches (12").....	0.0022

**Two-Way
Slabs**

Sec. 2618. (a) General. This construction, consisting of floors reinforced in two directions and supported on four sides, includes solid reinforced concrete slabs, concrete joists with fillers of hollow concrete units or clay tile, with or without concrete top slabs; and concrete joists with top slabs placed monolithically with the joists. The slab shall be supported by walls or beams on all sides and if not securely attached to supports, shall be reinforced as specified in Subsection (b).

(b) Reinforcement. Where the slab is not securely attached to the supporting beams or walls, special reinforcement shall be provided at exterior corners in both the bottom and top of the slab. This reinforcement shall be provided for a distance in each direction from the corner equal to one-fifth the longest span. The reinforcement in the top of the slab shall be parallel to the diagonal from the corner. The reinforcement in the bottom of the slab shall be at right angles to the diagonal or may be of bars in two directions parallel to the sides of the slab. The reinforcement in each band shall be of equivalent size and spacing to that required for the maximum positive moment in the slab.

(c) Design. The slab and its supports shall be designed by approved methods which shall take into account the effect of continuity at supports, the ratio of length to width of slab and the effect of two-way action.

(d) Slab Thickness. In no case shall the slab thickness be less than four inches (4") nor less than the perimeter of the

slab divided by 180. The spacing of reinforcement shall be not more than three times the slab thickness and the ratio of reinforcement shall be at least 0.0025.

**Two-Way
Slabs
(Continued)**

(c) **Details.** The details of design of two-way slabs shall conform to U.B.C. Standard No. 26-14-64.

Sec. 2619. (a) Shearing Unit Stress. The shearing unit stress " v " in reinforced concrete flexural members shall be computed by Formula (2):

**Shear and
Diagonal
Tension**

$$v = \frac{V}{bjd} \quad (2)$$

For beams of I- or T- section " b " shall be substituted for " b " in Formula (2).

In ribbed construction, where burned clay or concrete tile are used, " b " may be taken as a width equal to the thickness of the concrete web plus the thickness of the vertical shells of the concrete or burned clay tile in contact with the joist as specified in Sections 2616 and 2617.

Where the value of the shearing unit stress computed by Formula (2) exceeds the shearing unit stress " v_c " permitted on the concrete of an unreinforced web (see Section 2615), web reinforcement shall be provided to carry the excess. Such reinforcement shall also be provided for a distance equal to the depth of the member beyond the point theoretically required.

Where continuous or restrained beams or frames do not have a slab so cast as to provide T-beam action, the following provisions shall apply: Web reinforcement shall be provided from the support to a point beyond the extreme position of the point of inflection a distance equal to either one-sixteenth of the clear span or the depth of the member, whichever is greater, even though the shearing unit stress does not exceed " v_c ." Such reinforcement shall be designed to carry at least two-thirds of the total shear at the section. Web reinforcement shall be provided to carry at least two-thirds of the total shear at a section in which there is negative reinforcement.

(b) **Types of Web Reinforcement.** Web reinforcement may consist of:

1. Stirrups or web reinforcement bars perpendicular to the longitudinal steel.

2. Stirrups or web reinforcement bars welded or otherwise rigidly attached to the longitudinal steel and making an angle of 30 degrees or more thereto.

3. Longitudinal bars bent so that the axis of the inclined portion of the bar makes an angle of 15 degrees or more with the axis of the longitudinal portion of the bar.

4. Special arrangements of bars with adequate provisions to prevent slip of bars or splitting of the concrete by the reinforcement. [See Subsection (d), last paragraph.]

**Shear and
Diagonal
Tension
(Continued)**

Stirrups or other bars to be considered effective as web reinforcement shall be anchored at both ends, according to the provisions of Section 2620.

(c) **Stirrups.** The area of steel required in stirrups placed perpendicular to the longitudinal reinforcement shall be computed by Formula (3):

$$A_v = \frac{V's}{f_y d} \dots\dots\dots (3)$$

Inclined stirrups shall be proportioned by Formula (5).

Stirrups placed perpendicular to the longitudinal reinforcement shall not be used alone as web reinforcement when the shearing unit stress "v" exceeds $0.08f'_c$ or 240 pounds per square inch.

(d) **Bent Bars.** Only the center three-fourths of the inclined portion of any longitudinal bar that is bent up for web reinforcement shall be considered effective for that purpose, and such bars shall be bent around a pin having a diameter not less than six times the bar size.

When the web reinforcement consists of a single bent bar or of a single group of parallel bars all bent up at the same distance from the support, the required area of such bars shall be computed by Formula (4):

$$A_r = \frac{V'}{f_r \sin \alpha} \dots\dots\dots (4)$$

In Formula (4) "V'" shall not exceed $0.04f'_c bjd$, or $120 bjd$.

Where there is a series of parallel bars or groups of bars bent up at different distances from the support, the required area shall be determined by Formula (5):

$$A_r = \frac{V's}{f_y d (\sin \alpha + \cos \alpha)} \dots\dots\dots (5)$$

When bent bars are used alone as web reinforcement, they shall be so spaced that the effective inclined portion described above in this Subsection meets the requirements of Subsection (f) of this Section, and the allowable shearing unit stress shall not exceed $0.08 f'_c$ nor 240 pounds per square inch.

The shearing unit stress permitted when special arrangements of bars are employed shall be that determined by making comparative tests, to destruction, of specimens of the proposed system and of similar specimens reinforced in conformity with the provisions of this Code, the same factor of safety being applied in both cases.

(e) **Combined Web Reinforcement.** Where more than one type of reinforcement is used to reinforce the same portion of the web, the total shearing resistance of this portion of the

web shall be assumed as the sum of the shearing resistances computed for the various types separately. In such computations the shearing resistance of the concrete shall be included only once, and no one type of reinforcement shall be assumed

**Shear and
Diagonal
Tension
(Continued)**

to resist more than $\frac{2 V'}{3}$

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

Where web reinforcement is required, the amount used shall be not less than 0.15 per cent of the area computed as the product of the width of the member at mid-depth and the horizontal spacing of the web reinforcement.

(g) **Shearing Stress in Flat Slabs.** In flat slabs the shearing unit stress on vertical sections which follow the periphery "b" at a distance "d" beyond the edges of the column or column capital and parallel or concentric with it, shall not exceed the following values for the concrete when computed by Formula (2):

1. $0.03f'_c$, but not more than 100 pounds per square inch, when at least 50 per cent of the total negative reinforcement required for bending in the column strip passes through the periphery.

2. $0.025f'_c$, but not more than 85 pounds per square inch when 25 per cent, which is the least value permitted, of the negative reinforcement required for bending in the column strip passes through the periphery.

3. Proportionate values of the shearing unit stress for intermediate percentages of reinforcement.

Where drop panels are used, the shearing unit stress on vertical sections which lie at a distance "d" beyond the edges of the drop panel and parallel with them, shall not exceed $0.03f'_c$, nor 100 pounds per square inch. At least 50 per cent of the total negative reinforcement required for bending in the column strip shall be within the width of strip directly above the drop panel.

(h) **Shear and Diagonal Tension in Footings.** In isolated footings the shearing unit stress computed by Formula (2) on the critical section shall not exceed $0.03f'_c$, nor in any case shall it exceed 75 pounds per square inch. See Section 2623 (d).

Sec. 2620. (a) Computation of Bond Stress in Beams. In flexural members in which the tensile reinforcement is parallel

**Bond and
Anchorage**

**Bond and
Anchorage
(Continued)**

to the compression face, the bond stress at any cross section shall be computed by Formula (6):

$$u = \frac{V}{\sum_o j d l} \quad (6)$$

in which "V" is the shear at that section, and " $\sum_o$ " is taken as the perimeter of all effective bars crossing the section on the tension side. To be effective the bars must be properly developed by hooks, lap, or embedment on each side of the section. Bent-up bars that are not more than $d/3$ from the level of the main longitudinal reinforcement may be included. Critical sections occur at the face of the support, at each point where tension bars terminate within a span, and at the point of inflection.

Bond shall be similarly computed on compressive reinforcement, but the shear used in computing the bond shall be reduced in the ratio of the compressive force assumed in the bars to the total compressive force at the section. Anchorage shall be provided by embedment past the section to develop the assumed compressive force in the bars at the bond stress in Table No. 26-B.

Adequate end anchorage shall be provided for the tensile reinforcement in all flexural members to which Formula (6) does not apply, such as footings, brackets, and other tapered or stepped beams in which the tensile reinforcement is not parallel to the compression face.

(b) **Anchorage Requirements.** Tensile negative reinforcement in any span of a continuous, restrained, or cantilever beam, or in any member of a rigid frame shall be adequately anchored by bond, hooks, or mechanical anchors in or through the supporting member. Within any such span every reinforcing bar except in a lapped splice shall be extended at least 12 diameters beyond the point at which it is no longer needed to resist stress.

At least one-third of the total reinforcement provided for negative moment at the support shall be extended beyond the extreme position of the point of inflection a distance sufficient to develop by bond one-half the allowable stress in such bars, not less than one-sixteenth of the clear span length, or not less than the depth of the member, whichever is greater. The maximum tension in any bar must be developed by bond on a sufficient straight or bent embedment or by other anchorage. See Section 2620 (f).

The bar may be bent across the web at an angle of not less than 15 degrees with the longitudinal portion of the bar and be made continuous with the reinforcement which resists moment of opposite sign.

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

**Bond and
Anchorage
(Continued)**

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

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

(d) **Anchorage of Web Reinforcement.** The ends of bars forming simple U- or multiple U-stirrups shall be anchored by one of the following methods:

1. Welding to longitudinal reinforcement.
2. Bending tightly around the longitudinal reinforcement through at least 180 degrees.

3. Embedment above or below the mid-depth of the beam on the compression side, a distance sufficient to develop the stress to which the bar will be subjected at a bond stress of not to exceed $0.045f_c$ on plain bars or $0.10f_c$ on deformed bars, but in any case a minimum of 24 bar diameters.

4. By a standard hook, considered as developing 10,000 pounds per square inch plus embedment sufficient to develop by bond the remaining stress in the bar at the unit stress specified in Table No. 26-B. The effective embedded length of a stirrup leg shall be taken as the distance between the mid-depth of the beam and the tangent of the hook.

Between the continuous ends, each bend in the continuous portion of a U- or multiple U-stirrup shall be made around a longitudinal bar.

- Hooking or bending stirrups around the longitudinal reinforcement shall be considered effective only when these bars are perpendicular to the longitudinal reinforcement.

Longitudinal bars bent to act as web reinforcement shall, in a region of tension, be continuous with the longitudinal reinforcement. The tensile stress in each bar shall be fully developed in both the upper and the lower half of the beam by one of the following methods:

- I. As specified in Subsection (d) 3.
- II. As specified in Subsection (d) 4.

In all cases web reinforcement shall be carried as close to the compression surface of the beam as fire-protection regulations and the proximity of other steel will permit.

(e) **Anchorage of Bars in Footing Slabs.** Plain bars in footing slabs, except the longitudinal reinforcement between loads in continuous-slab footings, shall be anchored by means of standard hooks. The outer faces of these hooks and the ends of deformed bars shall be not less than three inches (3") nor more than six inches (6") from the face of the footing.

(f) **Hooks.** The terms "hook" or "standard hook" as used herein shall mean either:

**Bend and
Anchorage
(Continued)**

1. A complete semicircular turn with a radius of be the axis of the bar of not less than three and not more six bar diameters, plus an extension of at least four bar diameters at the free end of the bar.

2. A 90-degree bend having a radius of not less than bar diameters plus an extension of 12 bar diameters.

3. For stirrup anchorage only, a 135-degree turn with a radius on the axis of the bar of three diameters, plus an extension of at least six bar diameters at the free end of the bar.

Hooks having a radius of bend of more than six bar diameters shall be considered merely as extensions to the bar.

In general, hooks shall not be permitted in the tension of any beam except at the ends of simple or cantilever beams or at the freely supported ends of continuous beams.

No hook shall be assumed to carry a load which will produce a tensile stress in the bar greater than 10,000 psi per square inch.

Hooks shall not be considered effective in adding to the compressive resistance of bars.

Any mechanical device capable of developing the strength of the bar without damage to the concrete may be used in lieu of a hook. Tests must be presented to show the adequacy of such devices.

Flat Slabs

Sec. 2621. (a) Scope. The term "flat slab" shall mean a reinforced concrete slab supported by columns with or without flaring heads or column capitals, with or without pressed or drop panels and generally without beams or girders. Recesses or pockets in flat slab ceilings, located between reinforcing bars and forming cellular or two-way ribbed slabs, whether left open or filled with permanent fillers, shall not prevent a slab from being considered a flat slab if allowable unit stresses shall not be exceeded.

(b) Design of Flat Slabs as Continuous Frames. Any design of flat slab construction may be designed by application of the principles of continuity.

(c) Design of Flat Slabs by Moment Coefficients. Moment coefficients may be used when the construction conforms with the following:

1. The ratio of length to width of panel does not exceed 1:33.
2. The slab is continuous for at least three panels in each direction.
3. The successive span lengths in each direction differ not more than 20 per cent of the shorter span.

(d) Details. The details of the design and construction of flat slabs shall conform to U.B.C. Standard No. 26-1

**Reinforced
Concrete
Columns
and Walls**

2622. (a) Limiting Dimensions. The following Subsections (g) apply to a short column, for which the unsupported length is not greater than 10 times the least lateral dimension. When the unsupported length exceeds this value, design shall be modified as shown in Subsection (g). Spiral columns in buildings shall have a minimum diameter of twelve inches (12"), or in the case of rectangular columns, a minimum thickness of ten inches (10") and a minimum gross area of one hundred and twenty square inches (sq. in.). Posts that are not continuous from story to story shall have a minimum diameter or thickness of six inches (6").

(g) Unsupported Length of Columns. For purposes of limiting the limiting dimensions of columns, the unsupported length of reinforced concrete columns shall be taken as the clear distance between floor slabs.

EXCEPTIONS: 1. In flat slab construction, it shall be the clear distance between the floor and the lower extremity of the capital.

2. In beam-and-slab construction, it shall be the clear distance between the floor and the underside of the deeper beam framing into the column in each direction at the next higher floor level.

3. In columns restrained laterally by struts, it shall be the clear distance between consecutive struts in each vertical plane; provided that to be an adequate support, two struts shall meet the column at approximately the same level, and the angle between vertical planes through the struts shall not vary more than 15 degrees from a right angle. Such struts shall be of adequate dimensions and anchorage to restrain the column against lateral deflection.

4. In columns restrained laterally by struts or beams, with brackets used at the junction, it shall be the clear distance between the floor and the lower edge of the bracket, provided that the bracket width equals that of the beam strut and is at least half that of the column.

For rectangular columns, that length shall be considered which produces the greatest ratio of length to depth of section.

(b) Spirally Reinforced Columns. 1. Permissible Load. The maximum permissible axial load "P" on columns with closely spaced spirals enclosing a circular concrete core reinforced with longitudinal bars shall be that given by Formula (7):

$$P = A_g (0.225f_c + f_c p_s) \dots\dots\dots (7)$$

WHERE:

A_g = the gross area of the column.
 f_c = compressive strength of the concrete.

**Reinforced
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(Continued)**

f_s = nominal working stress in vertical column reinforcement, to be taken at 40 per cent of the minimum specification value of the yield point; viz., 16,000 pounds per square inch for intermediate-grade steel and 20,000 pounds per square inch for rail or hard-grade steel.¹

p_v = ratio of the effective cross-sectional area of vertical reinforcement to the gross area, A_g .

2. **Vertical reinforcement.** The ratio " p_v " shall be not less than 0.01 nor more than 0.08. The minimum number of bars shall be six, and the minimum diameter shall be five-eighths inch ($\frac{5}{8}$ "). The center-to-center spacing of bars within the periphery of the column core shall be not less than two and one-half times the diameter for round bars or three times the side dimension for square bars. The clear spacing between bars shall be not less than one and one-half inches ($1\frac{1}{2}$ "), or one and one-half times the maximum size of the coarse aggregate used. These spacing rules apply to adjacent pairs of bars at a lapped splice.

3. **Splices in vertical reinforcement.** Where lapped splices in the column verticals are used, the minimum amount of lap shall be as follows:

I. For deformed bars with concrete having an ultimate strength of 3000 pounds per square inch or above, 20 diameters of bar of intermediate or hard-grade steel. For bars of higher yield point, the amount of lap shall be increased one diameter for each 1000 pounds per square inch above 20,000 pounds per square inch working stress. When the concrete strengths are less than 3000 pounds per square inch, the amount of lap shall be one-third greater than the values given above.

II. For plain bars the minimum amount of lap shall be 100 per cent greater than that specified for deformed bars.

III. Welded splices or other positive connections may be used instead of lapped splices. Welded splices shall preferably be used in cases where the bar diameter exceeds one and one-half inches ($1\frac{1}{2}$ "). An approved welded splice shall be defined as one in which the bars are butted and welded and that will develop in tension at least the yield point stress of the reinforcing steel used.

IV. Where changes in the cross section of a column occur, the longitudinal bars shall be offset in a region where lateral support is afforded by a concrete capital, floor slab, or metal ties or reinforcing spirals. Where bars

¹Nominal working stresses for reinforcement of higher yield point may be established at 40 per cent of the yield point stress, but not more than 30,000 pounds per square inch, when the properties of such reinforcing steels have been definitely specified. If this is done, the lengths of splice required by Section 2622 (c) 3 shall be increased accordingly.

**Reinforced
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are offset, the slope of the inclined portion from the axis of the column shall not exceed one in six and the bars above and below the offset shall be parallel to the axis of the column.

4. **Spiral reinforcement.** The ratio of spiral reinforcement "p'" shall be not less than the value given by Formula (8):

$$p' = 0.45 (R - 1) \frac{f_c}{f_s} \dots\dots\dots (8)$$

WHERE:

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

R = ratio of gross area to core area of column, A_o/A_c .

f_s = useful limit stress of spiral reinforcement, to be taken as 40,000 pounds per square inch for hot-rolled rods of intermediate grade, 50,000 pounds per square inch for hard grade, and 60,000 pounds per square inch for cold-drawn wire.

The spiral reinforcement shall consist of evenly spaced continuous spirals held firmly in place and true to line by vertical spacers using at least two for spirals twenty inches (20") or less in diameter, three for spirals twenty inches (20") to thirty inches (30") in diameter, and four for spirals more than thirty inches (30") in diameter or composed of spiral rods five-eighths inch ($\frac{5}{8}$ ") or larger in size. The spirals shall be of such size and so assembled as to permit handling and placing without being distorted from the design dimensions. The material used in spirals shall have a minimum diameter of one-fourth inch ($\frac{1}{4}$ ") for rolled bars or No. 4 U. S. gauge for drawn wire. Anchorage of spiral reinforcement shall be provided by one and one-half extra turns of spiral rod or wire at each end of the spiral unit. Splices, when necessary, shall be made in spiral rod or wire by welding or by a lap of one and one-half turns. The center-to-center spacing of the spirals shall not exceed one-sixth of the core diameter. The clear spacing between spirals shall not exceed three inches (3") nor be less than one and three-eighths inches ($1\frac{3}{8}$ ") or one and one-half times the maximum size of coarse aggregate used. The reinforcing spiral shall extend from the floor level in any story, or from the top of the footing in the basement, to the level of the lowest horizontal reinforcement in the slab, dropped panel, or beam above. In a column with a capital, it shall extend to the plane at which the diameter or width of the capital is twice that of the column.

5. **Protection of reinforcement.** The column reinforcement shall be protected everywhere by a covering of concrete cast monolithically with the core, for which the thickness shall be not less than one and one-half inches ($1\frac{1}{2}$ ") nor less than one and one-half times the maximum size of the coarse aggre-

**Reinforced
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gate, nor shall it be less than required by the fire-protection and weathering provisions specified in Section 2610 (f).

6. Limits of column section. For columns built monolithically with concrete walls or piers, the outer boundary of the column section shall be taken either as a circle at least one and one-half inches ($1\frac{1}{2}$ ") outside the column spiral or as a square or rectangle of which the sides are at least one and one-half inches ($1\frac{1}{2}$ ") outside the spiral. The value of " A_v " thus defined shall be used in both Formulas (7) and (8). In any case it shall be permissible to design a circular column and to build it as a square column of the same least lateral dimension. In such case the permissible load, the gross area considered, and the required percentage of reinforcement must be taken as those of the circular column.

(d) **Tied Columns. 1. Permissible load.** The maximum permissible axial load on columns reinforced with longitudinal bars and separate lateral ties shall be 80 per cent of that given by Formula (7). The ratio " p_v " to be considered in tied columns shall not be less than 0.01 nor more than 0.04. The longitudinal reinforcement shall consist of at least four bars, of minimum diameter of five-eighths inch ($\frac{5}{8}$ "). Splices in reinforcing bars shall be made as described in Subsection (c) 3.

2. Lateral ties. Lateral ties shall be at least one-fourth inch ($\frac{1}{4}$ ") in diameter and shall be spaced apart not over 16 bar diameters, 48 tie diameters or the least dimension of the column. When there are more than four vertical bars, additional ties shall be provided so that every longitudinal bar is held firmly in its designed position and has lateral support equivalent to that provided by a 90-degree corner of a tie.

3. Limits of column section. In a tied column which for architectural reasons has a larger cross section than required by consideration of loading, a reduced effective area " A_v " not less than one-half of the total area may be used in applying the provisions of Subsection (d) 1.

4. Combined axial and bending load. For tied columns which are designed to withstand combined axial and bending stresses, the limiting steel ratio of 0.04 may be increased to 0.08. The amount of steel spliced by lapping shall not exceed a steel ratio of 0.04 in any three-foot (3') length of column. The size of the column designed under this provision shall in no case be less than that required to withstand the axial load alone with a steel ratio of 0.04.

(e) **Composite Columns. 1. Permissible load.** The permissible load on a composite column consisting of a structural steel or cast iron column thoroughly encased in concrete reinforced with both longitudinal and spiral reinforcement, shall not exceed that given by Formula (9):

$$P = 0.225 A_v f'_c + f_s A_s + f_s A_s \dots \dots \dots (9)$$

WHERE:

A_c = net area of concrete, $= A_g - A_s - A_r$.

A_s = cross-sectional area of longitudinal bar reinforcement.

A_r = cross-sectional area of the steel or cast iron core.

f_r = permissible unit stress in metal core, not to exceed 16,000 pounds per square inch for a steel core; or 10,000 pounds per square inch for a cast iron core.

The remaining notation is that of Subsection (c).

2. **Details of metal core and reinforcement.** The cross-sectional area of the metal core shall not exceed 20 per cent of the gross area of the column. If a hollow metal core is used it shall be filled with concrete. The amounts of longitudinal and spiral reinforcement and the requirements as to spacing of bars, details of splices, and thickness of protective shell outside the spiral shall conform to the limiting values specified in Subsection (c), paragraphs 2, 3, 4, and 5. A clearance of at least three inches (3") shall be maintained between the spiral and the metal core at all points, except that when the core consists of a structural steel H-column the minimum clearance may be reduced to two inches (2").

3. **Splices and connections of metal cores.** Metal cores in composite columns shall be accurately milled at splices and positive provision shall be made for alignment of one core above another. At the column base, provision shall be made to transfer the load to the footing at safe unit stresses in accordance with Section 2615 and Table No. 26-B. The base of the metal section shall be designed to transfer the load from the entire composite column to the footing, or it may be designed to transfer the load from the metal section only, provided it is so placed in the pier or pedestal as to leave ample section of concrete above the base for the transfer of load from reinforced concrete section of the column by means of bond on the vertical reinforcement and by direct compression on the concrete. Transfer of loads to the metal core shall be provided for by the use of bearing members such as billets, brackets, or other positive connections; these shall be provided at the top of the metal core and at intermediate floor levels where required. The column as a whole shall satisfy the requirements of Formula (9) at any point; in addition to this, the reinforced concrete portion shall be designed to carry, in accordance with Formula (7), all floor loads brought onto the column at levels between the metal brackets or connections. In applying Formula (7), the value of " A_c " shall be interpreted as the area of the concrete section outside the metal core, and the permissible load on the reinforced concrete section shall be further limited to $0.35f'_cA_c$. Ample section of concrete and continuity of reinforcement shall be provided at the junction with beams or girders.

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4. **Permissible load on metal core only.** The metal cores of composite columns shall be designed to carry safely any construction or other loads to be placed upon them prior to their encasement in concrete.

(f) **Combination Columns.** 1. **Steel columns encased in concrete.** The permissible load on a structural steel column which is encased in concrete at least two and one-half inches ($2\frac{1}{2}$ ") thick over all metal (except rivet heads) reinforced as hereinafter specified, shall be computed by Formula (10):

$$P = A_r f'_r \left(1 + \frac{A_g}{100 A_r} \right) \dots\dots\dots (10)$$

WHERE:

A_r = cross-sectional area of steel column.

f'_r = permissible stress for uneucased steel column.

A_g = total area of concrete section.

The concrete used shall develop a compressive strength " f'_c " of at least 2000 pounds per square inch at 28 days. The concrete shall be reinforced by the equivalent of welded-wire mesh having wires of No. 10 U. S. gauge, the wires encircling the column being spaced not more than four inches (4") apart and those parallel to the column axis not more than eight inches (8") apart. This mesh shall extend entirely around the column at a distance of one inch (1") inside the outer concrete surface and shall be lap-spliced at least 40 wire diameters and wired at the splice. Special brackets shall be used to receive the entire floor load at each floor level. The steel column shall be designed to carry safely any construction or other loads to be placed upon it prior to its encasement in concrete.

2. **Pipe columns.** The permissible load on columns consisting of steel pipe filled with concrete shall be determined by Formula (11):

$$P = 0.225 f'_r A_r + f'_r A_c \dots\dots\dots (11)$$

The value of " f'_r " shall be that given by Formula (12):

$$f'_r = \left(18,000 - 70 \frac{h}{K} \right) F \dots\dots\dots (12)$$

WHERE:

f'_r = average unit stress in metal core.

h = unsupported length of column.

K = least radius of gyration of metal core section.

(yield point of pipe)

$$F = \frac{\quad}{45,000}$$

If the yield point of the pipe is not known, the factor "F" shall be taken as 0.5.

(g) **Long Columns.** The maximum permissible load "P" on axially loaded reinforced concrete or composite columns having a length "h" greater than 10 times the least lateral dimension "d" shall be given by Formula (13):

$$P' = P \left(1.3 - .03 \frac{h}{d} \right) \dots\dots\dots (13)$$

where "P" is the permissible axial load on a short column as given by Subsections (c), (d), and (e).

The maximum permissible load "P" on eccentrically loaded columns in which "h/d" exceeds 10 shall also be given by Formula (13) in which "P" is the permissible eccentrically applied load on a short column as determined by the provisions of Subsections (i) and (j). In long columns subjected to definite bending stresses, as determined in Subsection (h), the ratio "h/d" shall not exceed 20.

(h) **Bending Moments in Columns.** When the stiffness and strength of the columns are utilized to reduce moments in beams, girders, or slabs, as in the case of rigid frames, or in other forms of continuous construction wherein column moments are unavoidable, they shall be provided for in the design. In computing moments in columns, the far ends may be considered fixed. Columns shall be designed to resist the axial forces from loads on all floors, plus the maximum bending due to loads on a single adjacent span of the floor.

(i) **Columns Subjected to Axial Load and Bending.** 1. Members subject to an axial load and bending in one principal plane, but with that ratio of eccentricity to depth "e/t" no greater than two-thirds, shall be so proportioned that:

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \text{ does not exceed unity} \dots\dots\dots (14)$$

2. When bending is oblique to the principal axes, Formula (14) becomes:

$$\frac{f_a}{F_a} + \frac{f_{bx}}{F_b} + \frac{f_{by}}{F_b} \text{ does not exceed unity} \dots\dots\dots (15)$$

where "f_a" and "f_{by}" are the bending moment components about the "x" and "y" principal axes divided by the section modulus of the transformed section relative to the respective axes, provided that the ratio "e/t" is no greater than two-thirds in either direction.

3. In designing a column subject to both axial load and bending, the preliminary selection of the column may be

**Reinforced
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(Continued)

made by use of an equivalent axial load given by Formula (16):

$$P = N \left(1 + \frac{Be}{t} \right)^2 \dots\dots\dots (16)$$

When bending exists on both of the principal axes, the quantity “Be/t” is the numerical sum of the “Be/t” quantities in the two directions.

4. For columns in which the load “N” has an eccentricity “e” greater than two-thirds the column depth “t,” the determination of the fiber stress “f_c” shall be made by use of recognized theory for cracked sections, based on the assumption that the concrete does not resist tension. In such cases the effectiveness of compressive reinforcement may be taken at twice the value indicated from calculations assuming a straight-line relation between stress and strain and the modular ratio given in Section 2613, but not greater than the allowable stress in tension. The maximum combined compressive stress in the concrete shall not exceed 0.45f_c. For such cases the tensile steel stress shall also be investigated.

(j) Walls. 1. Lateral and eccentric loads. Walls shall be designed for any lateral or other loads to which they are subjected. Proper provision shall be made for eccentric loads.

2. Height and thickness. The thickness of reinforced concrete bearing walls shall be not less, and the maximum height, number of stories, and distance between supports shall be not more, than as set forth in Table No. 26-C.

EXCEPTION: The provisions of this paragraph may be waived when written evidence is submitted by a qualified person showing that the walls meet all the other requirements of this Code.

3. Design. The maximum allowable compressive stress in reinforced concrete bearing walls with minimum reinforcement as required by this Subsection shall not exceed:

$$\left[1 - \left(\frac{h}{30d} \right)^2 \right] 0.2f_c \dots\dots\dots (17)$$

When the reinforcement in bearing walls is designed, placed, and anchored in position as for columns, the working stresses shall be on the basis of formulas for columns. For calculating

¹For trial computations “B” may be taken from three to three and one-half for rectangular columns, the lower value being used for columns with the maximum amount of reinforcement. Similarly for circular spiral columns, the value of “B” from five to six may be used.

wall stresses, concentrated loads may be assumed to be distributed over a maximum length of wall not exceeding the center-to-center distance between loads nor five times the width of the bearing.

The area of the horizontal reinforcement of reinforced concrete walls shall be not less than 0.0025; and that of the vertical reinforcement not less than 0.0015 times the area of the reinforced section of the wall if of bars, and not less than three-fourths as much if of welded wire fabric. Walls more than ten inches (10") thick, except for basement walls, shall have the reinforcement for each direction placed in two layers parallel with the faces of the wall. One layer consisting of not less than one-half and not more than two-thirds the total required shall be placed not less than two inches (2") nor more than one-third the thickness of the wall from the exterior surface. The other layer, comprising the balance of the required reinforcement, shall be placed not less than three-fourths inch ($\frac{3}{4}$ ") and not more than one-third the thickness of the wall from the interior surface. Bars, if used, shall be not less than No. 3 bars nor shall they be spaced more than eighteen inches (18") on center. Welded wire reinforcement for walls shall be in sheet form and spaced not less than four inches (4") center-to-center of the wires.

Reinforced concrete walls shall be anchored as specified in Section 2313.

(k) **Nonbearing Partitions.** Nonbearing partitions of reinforced concrete shall have a thickness of not less than one forty-eighth of the distance between their supports nor less than two inches (2").

(l) **Precast Solid Wall Panels.** 1. **Wall thickness.** The thickness of wall panels shall be governed by the structural requirements called for by other sections of this Code, and where applicable by the fire-resistive time-period rating set forth in Table No. 43-B.

2. **Wall height.** The height of panels shall be as specified in Subsection (j).

EXCEPTION: Where panels are designed to span horizontally to columns or isolated footings, the ratio of height to thickness shall not be limited, provided the effects of

**Reinforced
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(Continued)**

**TABLE NO. 26-C—REQUIREMENTS FOR REINFORCED CONCRETE
BEARING WALLS**

MAXIMUM HEIGHT (feet)	STORY	LIMITING RATIO— DISTANCE BETWEEN SUPPORTS TO WALL THICKNESS	MINIMUM THICKNESS (inches)
38	3	25	6
	2		7 6
	1		7 7 6
	Basement		8 8 8

**Reinforced
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(Continued)**

deep beam action and buckling are provided for in the design.

3. **Shear.** For loads parallel to the plane of the wall, the clear distance between supporting or enclosing members shall not exceed 16 times the thickness of the panel, except that this ratio may be increased to a maximum of 36 provided the unit shear stress does not exceed that given in the equation:

$$v = \frac{.45f'_c}{1 + \frac{(L/t)^2}{40}}$$

WHERE:

L = Clear distance between supporting or enclosing members (vertical or horizontal stiffening elements).

t = Thickness of the panel.

4. **Reinforcement.** The provisions of Subsection (j) shall govern the minimum requirements for reinforcing steel except as specified in the following Paragraph 5.

5. **Joints.** Vertical and horizontal joints shall be designed to resist all design forces, weather, and fire exposure necessary, and provide a minimum tie at the top and bottom of panels capable of resisting a force of 10,000 pounds each. Ties shall also be provided in the vertical joint equivalent to 50 per cent of the horizontal wall steel requirements of reinforced concrete, with allowable spacing of ties equal to 12 times the panel thickness. Horizontal joints between precast elements shall be similar to the vertical joint.

6. **Anchorage.** Wall panels shall be anchored to all floors and roofs as specified in Section 2313. Where continuous footings are used, anchorage at the bottom of the wall may be effected by a continuous key.

7. **Stresses.** Except as otherwise provided in this Section, allowable stresses shall comply with this Chapter.

The allowable unit shear stress between precast and poured elements shall not exceed that set forth in Table No. 24-B, for unit masonry laid up in cement mortar unless shear keys are provided. Where reinforcing bars are used as ties, the shear value for bolts set forth in Table No. 26-D, may be used.

Footings

Sec. 2623. (a) Loads and Reactions. Footings shall be proportioned to sustain the applied loads and induced reactions without exceeding the allowable stresses as prescribed in Section 2615, and as further provided in this Section and in Section 2626 (e) for plain concrete.

In cases where the footing is concentrically loaded and the member being supported does not transmit any moment

to the footing, computations for moments and shears shall be based on an upward reaction assumed to be uniformly distributed per unit area or per pile and a downward applied load assumed to be uniformly distributed over the area of the footing covered by the column, pedestal, wall, or metallic column base.

**Footings
(Continued)**

In cases where the footing is eccentrically loaded or the member being supported transmits a moment to the footing, proper allowance shall be made for any variation that may exist in the intensities of reaction and applied load consistent with the magnitude of the applied load and the amount of its actual or virtual eccentricity.

In the case of footings on piles, computations for moments and shears may be based on the assumption that the reaction from any pile is concentrated at the center of the pile.

(b) **Sloped or Stepped Footings.** In sloped or stepped footings, the angle of slope or depth and location of steps shall be such that the allowable stresses are not exceeded at any section.

In sloped or stepped footings, the effective cross section in compression shall be limited by the area above the neutral plane.

Sloped or stepped footings shall be cast as a unit.

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

The greatest bending moment required in the design of an isolated footing shall be the moment so computed at sections located as follows:

1. At the face of the column, pedestal, or wall, for footings supporting a concrete column, pedestal, or wall.
2. Halfway between the middle and the edge of the wall, for footings under masonry walls.
3. Halfway between the face of the column or pedestal and the edge of the metallic base, for footings under metallic bases.

TABLE NO. 26-D—ALLOWABLE SHEAR ON BOLTS

DIAMETER (Inches)	EMBEDMENT (Inches)	SHEAR (Pounds)
1/2	4	750
5/8	4	1000
3/4	5	1500
7/8	6	2000
1	7	2500
1 1/4	8	3000
1 1/2	9	3500

Footings
(Continued)

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

In one-way reinforced footings, the total tensile reinforcement at any section shall provide a moment of resistance at least equal to the moment computed as specified in this Section, and the reinforcement thus determined shall be distributed uniformly across the full width of the section.

In two-way reinforced footings, the total tensile reinforcement at any section shall provide a moment of resistance at least equal to 85 per cent of the moment computed as specified in this Section, and the total reinforcement thus determined shall be distributed across the corresponding resistance section in the following manner:

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

In two-way rectangular footings, the reinforcement in the long direction shall be distributed uniformly across the full width of the footing. In the case of the reinforcement in the short direction, that portion determined by Formula (1) shall be uniformly distributed across a band-width "B" centered with respect to the center line of the column or pedestal and having a width equal to the length of the short side of the footing. The remainder of the reinforcement shall be uniformly distributed in the outer portion of the footing.

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

where "S" is the ratio of the long side to the short side of the footing.

(d) **Shear and Bond.** The critical section for shear shall be assumed as a vertical section obtained by passing a series of vertical planes through the footing, each of which is parallel to the corresponding face of the column, pedestal, or wall and located at a distance therefrom equal to the depth for footings on soil, and one-half the depth for footings on piles.

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

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

mputations for shear to be used as a measure of bond be based on the same section and loading as specified in the determination of external bending moment in Section (c).

The total tensile reinforcement at any section shall provide resistance at least equal to the bond requirement as stated from the following percentages of the external load at the section:

In one-way reinforced footings, 100 per cent.

In two-way reinforced footings, 85 per cent.

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

Shearing and bond stresses shall not exceed those specified in Sections 2615, 2619, and 2620.

Transfer of Stress at Base of Column. The stress in longitudinal reinforcement of a column or pedestal shall be transferred to its supporting pedestal or footing either by bending the longitudinal bars into the supporting member or by dowels.

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

In cases where dowels are used, their total sectional area shall be not less than the sectional area of the longitudinal reinforcement in the member from which the stress is being transferred. In no case shall the number of dowels per member be less than four and the diameter of the dowels shall not exceed the diameter of the column bars by more than 1/8 inch (1/8").

Dowels shall extend up into the column or pedestal a distance at least equal to that specified in Section 2622 (c) 3, plus the lap of longitudinal column bars and down into the supporting pedestal or footing the distance required to transfer the stress in the concrete, by allowable bond stress, the full working stress of the dowel.

The compressive stress in the concrete at the base of a column or pedestal shall be considered as being transferred to the top of the supporting pedestal or footing.

Footings
(Continued)

**Footings
(Continued)**

The unit compressive stress on the loaded area shall not exceed the bearing stress allowable for the quality of concrete in the supporting member as limited by the ratio of the loaded area to the supporting area.

Bearing stresses shall not exceed those set forth in Table No. 26-B.

In sloped or stepped footings, the supporting area for bearing may be taken as the top horizontal surface of the footing, or assumed as the area of the lower base of the largest frustum of a pyramid or cone contained wholly within the footing and having for its upper base the area actually loaded, and having side slopes of one vertical to not more than two horizontal.

(f) **Footings Supporting Round Columns.** In computing the stresses in footings which support a round or octagonal concrete column or pedestal, the "face" of the column or pedestal shall be taken as the side of a square having an area equal to the area enclosed within the perimeter of the column or pedestal.

(g) **Minimum Edge-thickness.** In reinforced concrete footings, the thickness above the reinforcement at the edge shall be not less than six inches (6") for footings on soil, nor less than twelve inches (12") for footings on piles.

**Precast
Concrete
Joists**

Sec. 2624. The depth of precast concrete joists shall be not more than four times the width of the top or bottom flanges nor less than one-twenty-fourth of the span length.

The thickness of the top slab shall be not less than one-twelfth of the clear span between joists nor less than two inches (2") for roofs or floors and not less than one and one-half inches (1½") over the joists. The slab shall have not less than 0.2 per cent reinforcement at right angles to the span of joists. The reinforcement shall be spaced not farther apart than five times the slab thickness.

When the top slab is adequately reinforced and bonded to the joist, the construction may be considered as a T-beam.

**Composite
Beams**

Sec. 2625. The term "composite construction" shall apply to any combination of structural elements which are designed to carry loads jointly; provided:

1. Attention is given to whether loads are applied to the individual elements or to the composite member.

2. Physical properties of the composite section are computed, assuming complete interaction between component elements.

3. Provision is made at the plane that joins two elements to resist all shear and other forces that may tend to separate the elements.

4. The ultimate strength of a composite member shall be computed in the same manner as ultimate strength of an integral member of the same shape.

Sec. 2626. (a) General. Plain concrete, other than fill, shall have a minimum ultimate compressive strength at 28 days of 2000 pounds per square inch, and material, proportioning, and placing shall conform to the requirements of this Chapter. Concrete made with lightweight aggregates may be used with strengths less than 2000 pounds per square inch if it has been shown by tests or experience to have sufficient strength and durability.

**Plain
Concrete**

Provisions shall be made to care for temperature and shrinkage stresses either by use of reinforcement or by means of joints.

Plain concrete construction shall conform to the detailed minimum requirements specified in this Chapter. Where Section 2314 is applicable, plain concrete shall also be designed in accordance with the allowable stresses specified in this Chapter.

(b) Wall Thickness. The thickness of plain concrete walls may be two inches (2") less than required by Section 2417 (b) for plain masonry walls but in no case less than seven inches (7"), and the ratio of unsupported height or length (whichever is the lesser) to thickness shall be not greater than 22.

(c) Design. Plain concrete walls shall be designed to withstand all vertical and horizontal loads as specified in Chapter 23.

(d) Stresses. The allowable working stresses in plain concrete walls shall not exceed the following percentages of ultimate strength:

Compression	.25 f'_c
Tension	.01 f'_c
Shear	.02 f'_c

(e) Pedestals and Footings (Plain Concrete). The allowable compressive unit stress on the gross area of a concentrically loaded pedestal shall not exceed $0.25f'_c$. Where this stress is exceeded, reinforcement shall be provided and the member designed as a reinforced concrete column.

The depth and width of a pedestal or footing of plain concrete shall be such that the tension in the concrete shall not exceed $0.03f'_c$ and the average shearing stress shall not exceed $0.02f'_c$ taken on critical sections as determined for reinforced concrete footings. The thickness at the edge shall be not less than eight inches (8") for footings on soil, nor less than fourteen inches (14") above the tops of the piles for footings on piles.

Sec. 2627. (a) General. For the purpose of this Chapter all pneumatically placed concrete shall consist of a mixture of fine aggregate and cement pneumatically applied by suitable mechanism, and to which water is added immediately prior to discharge from the applicator.

**Pneumatically
Placed
Concrete**

pneumatically
placed
concrete
(Continued)

Except as specified in the following Subsections of this Section, all pneumatically placed concrete shall conform to the regulations of this Chapter for concrete.

(b) **Proportions.** The proportion of cement to aggregate, in loose dry volumes, shall be not less than one to four and one-half.

(c) **Water.** The water content at the time of discharge, including any moisture in the fine aggregate, shall not exceed three and one-half gallons per sack of cement.

(d) **Mixing.** The cement and aggregate shall be thoroughly mixed prior to the addition of water. At the time of mixing the fine aggregate shall contain not less than three per cent moisture.

(e) **Rebound.** Any rebound or accumulated loose aggregate shall be removed from the surface to be covered prior to placing the initial or any succeeding layers of pneumatically placed concrete. Rebound may be re-used if it conforms to the requirements for aggregate, but not in excess of 25 per cent of the total aggregate in any batch.

(f) **Joints.** Unfinished work shall not be allowed to stand for more than 30 minutes unless all abrupt edges are sloped to a thin edge. Before resuming work, this sloped portion shall be cleaned and wetted.

(g) **Damage.** Any pneumatically placed concrete which subsides after placement shall be removed.

bolts

Sec. 2628. Bolts shall be solidly embedded in plain or reinforced concrete, and the connection shall be designed so that the shear on every bolt is not more than the values set forth in Table No. 26-D.

Minimum Slab
thickness

Sec. 2629. The minimum thickness of concrete floor slabs supported directly on the ground shall be not less than three and one-half inches ($3\frac{1}{2}$ ").

CHAPTER 27—STEEL AND IRON

Sec. 2701. (a) **General.** The quality and design of steel and iron used structurally in buildings or structures shall conform to the requirements specified in this Chapter and to the following standards:

Material Standard and Symbols

MATERIAL AND DESIGN	U.B.C. DESIGNATION
STRUCTURAL STEEL	
Material Specifications.....	27- 1-64
Erection, Fabrication, Identification and Painting.....	27- 2-64
Stress Variation or Stress Reversal Design.....	27- 3-64
Open Web Steel Joist Design.....	27- 4-64
CONNECTIONS	
Rivet Steel.....	27- 5-64
Welding.....	27- 6-64
High Tensile Bolts.....	27- 7-64
COMPOSITE DESIGN	27- 8-64
LIGHT STEEL FOR STRUCTURAL MEMBERS	
Material Specifications.....	27- 9-64
Design.....	27-10-64

(b) **Identification.** Structural steel shall be identified by the mill in accordance with U.B.C. Standard No. 27-2-64. Where structural steel is furnished to a specified minimum yield point greater than 36,000 pounds per square inch the A.S.T.M. specification number shall be printed near the erection mark on each shipping assembly. An affidavit shall be furnished by the fabricator when required by the Building Official certifying that the strength grades of steel called for on the plans have been furnished.

(c) **Symbols and Notations.** The symbols and notations used in these regulations are defined as follows:

A_b = Nominal body area of a bolt.

A_c = Actual area of effective concrete flange in composite design as defined in Section 2708 (a).

A_{bc} = Planar area of web at beam to column connection.

A_f = Area of compression flange.

A_s = Area of steel beam in composite design.

A_{st} = Cross-sectional area of stiffener or pair of stiffeners.

A_w = Area of girder web.

B = Coefficient used in column formula for plastic design.

C_b = Bending coefficient dependent upon moment gradient; equal to

$$1.75 - 1.05 \left(\frac{M_1}{M_2} \right) + 0.3 \left(\frac{M_1}{M_2} \right)^2$$

**Material Standards
and Symbols
(Continued)**

C_c = Column slenderness ratio dividing elastic and inelastic buckling; equal to

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

C_m = Coefficient applied to bending term in interaction formula and dependent upon column curvature caused by applied moments.

C_v = Ratio of "critical" web stress, according to the linear buckling theory, to the shear yield point of web material; equal to

$$\frac{\pi^2 E k \sqrt{3}}{12 (1 - \nu^2) (h/t)^2 F_y}$$

D = Factor depending upon type of transverse stiffeners.

E = Modulus of elasticity of steel (29,000,000 pounds per square inch).

E_c = Modulus of elasticity of concrete.

F_a = Axial stress permitted in the absence of bending moment.

F_{as} = Axial compressive stress, permitted in the absence of bending moment, for bracing and other secondary members.

F_b = Bending stress permitted in the absence of axial force.

F'_b = Allowable bending stress in compression flange of plate girders as reduced because of large web depth-to-thickness ratio.

F'_e = Euler stress divided by factor of safety; equal to

$$\frac{149,000,000}{\left(\frac{K l_b}{r_b} \right)^2}$$

F_p = Allowable bearing stress.

F_t = Allowable tensile stress.

F_v = Allowable shear stress.

F_y = Specified minimum yield point of the type of steel being used.

G = Coefficient used in column formula in plastic design.

H = Coefficient used in column formula in plastic design.

I_{tr} = Moment of inertia of transformed composite section.

J = Coefficient used in column formula in plastic design.

- K = Effective length factor.
 L = Span length, in feet.
 L_u = Maximum unbraced length of compression flange in feet for which full bending stress is permitted by Formula (5).
 M = Moment.
 M_1 = Smaller end moment on unbraced length of beam-column.
 M_2 = Larger end moment on unbraced length of beam-column.
 M_D = Moment produced by dead load.
 M_L = Moment produced by live load.
 M_o = Reduced plastic moment.
 M_p = Plastic moment.
 N = Length of bearing of applied load.
 P = Applied load.
 P_y = Plastic axial load; equal to profile area times specified minimum yield point.
 R = Reaction or concentrated transverse load applied to beam or girder.
 S_s = Section modulus of steel beam used in composite design, referred to the tension flange.
 S_{tr} = Section modulus of transformed composite cross section, referred to the tension flange.
 T_b = Proof load of a high strength bolt.
 V = Statical shear on beam.
 V_h = Total horizontal shear to be resisted by connectors.
 V_u = Statical shear produced by "ultimate" load in plastic design.
 Y = Ratio of yield point of web steel to yield point of stiffener steel.
 a = Clear distance between transverse stiffeners.
 a' = Distance required at ends of welded partial length cover plate to develop stress.
 b = Effective width of concrete slab.
 b_f = Flange width of rolled beam or plate girder.
 c = Distance from neutral axis to extreme fiber of beam.
 d = Depth of beam or girder. Also diameter of roller or rocker bearing.
 e = Horizontal displacement, in the direction of the span, between top and bottom of simply supported beam at its ends.
 f_a = Computed axial stress.
 f_b = Computed bending stress.
 f'_c = Specified compression strength of concrete at 28 days.
 f_t = Computed tensile stress.
 f_v = Computed shear stress, in pounds per square inch.

**Material Standards
and Symbols
(Continued)**

f_{vs}	= Shear between girder web and transverse stiffeners, in pounds per linear inch of single stiffener or pair of stiffeners.
g	= Transverse spacing between fastener gauge
h	= Clear distance between flanges of a beam or girder.
k	= Coefficient relating linear buckling strength of plate to its dimensions and condition of edge support. Also distance from outer face of flange web toe of fillet.
l	= Actual unbraced length, in inches.
l_b	= Actual unbraced length in plane of bending, in inches.
l_{cr}	= Critical unbraced length adjacent to plastic hinge, in inches.
n	= Modular ratio; equal to " E/E_c ."
q	= Allowable horizontal shear to be resisted by a connector.
r	= Governing radius of gyration.
r_b	= Radius of gyration about axis of concurrent bending.
r_y	= Lesser radius of gyration.
s	= Spacing (pitch) between successive holes in plate, in inches.
t	= Girder or beam web thickness.
t_f	= Flange thickness.
t_t	= Thickness of thinner part joined by partial penetration groove weld.
w	= Web thickness of plastically designed members. Also length of channel shear connector.
ν	= Poisson's ratio.

**Allowable
Unit Stresses**

Sec. 2702. (a) General. Except as provided in Sections 2703, 2704, 2707, 2708 and 2721, all components of the structure shall be so proportioned that the unit stress, in pounds per square inch, shall not exceed the values specified in this Section.

(b) Structural Steel. 1. Tension. On the net section at pinholes

$$F_t = 0.60F_y$$

On the net section at pinholes in eyebars, pin-connection plates or built-up members

$$F_t = 0.45F_y$$

2. Shear. On the gross section

$$F_v = 0.40F_y$$

See Section 2707 for reduction required for thin webs.

Compression. On the gross section of axially loaded compression members when " Kl/r ," the largest effective slenderness ratio of any unbraced segment as defined in Section 2701 is less than " C_c ."

**Allowable
Unit Stresses
(Continued)**

$$F_a = \frac{\left[1 - \frac{(Kl/r)^2}{2C_c^2} \right] F_y}{\text{F.S.}} \quad \text{Formula (1)}$$

RE:

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

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

the gross section of axially loaded columns when " Kl/r " exceeds " C_c "

$$F_a = \frac{149,000,000}{(Kl/r)^2} \quad \text{Formula (2)}$$

the gross section of axially loaded bracing and second-moment members, when " l/r " exceeds 120 (for this case " K " is as unity)

$$F_{as} = \frac{F_a \text{ (by Formula 1 or 2)}}{1.6 - \frac{l}{200r}} \quad \text{Formula (3)}$$

the gross area of plate girder stiffeners

$$F_a = 0.60F_y$$

the web of rolled shapes at the toe of the fillet for bending.

$$F_a = 0.75F_y$$

web stiffeners shall be provided as specified in Section 2707 when the compressive stress at the web toe exceeds the allowable stress specified in the preceding paragraph.

Bending. Tension and compression on extreme fibers of fully supported compact rolled shapes and compact built-up members having an axis of symmetry in the plane of loading.

$$F_b = 0.66F_y$$

the web depth-to-thickness ratio for a compact member subjected to bending forces shall not be greater than:

Allowable
Unit Stresses
(Continued)

$$\frac{13,300}{\sqrt{F_y}} \quad \text{AND}$$

The web depth-to-thickness ratio for a compact member subjected to combined axial and bending forces shall not be greater than:

$$13,300 \left(\frac{1 - 1.43 f_a/F_a}{\sqrt{F_y}} \right)$$

but need not be less than:

$$\frac{8000}{\sqrt{F_y}}$$

The width-to-thickness ratio of projecting elements of compression flanges for rolled shapes classified as compact members shall not exceed:

$$\frac{1650}{\sqrt{F_y}} \quad \text{AND}$$

The width-to-thickness ratio of projecting elements of compression flanges for built-up shapes classified as compact members shall not exceed:

$$\frac{1600}{\sqrt{F_y}}$$

The width-to-thickness ratio measured between longitudinal lines of flange connections of flange plates in box sections classified as compact members shall not exceed

$$\frac{6000}{\sqrt{F_y}}$$

Flanges of compact built-up sections shall be continuously connected to the web or webs.

Compact members shall be assumed as laterally supported when the distance in inches between points of support of the compression flange does not exceed

$$\frac{2400 b_f}{\sqrt{F_y}} \quad \text{OR}$$

$$\frac{20,000,000 A_f}{d F_y}$$

Beams and girders which meet the requirements as compact members and are continuous over supports or are rigidly framed to columns by means of rivets, high strength bolts or welds, may be proportioned for nine-tenths of the negative moments produced by gravity loading which are maximum

**Allowable
Unit Stresses
(Continued)**

at points of support, provided that, for such members, the maximum positive moment shall be increased by one-tenth of the average negative moments. This reduction shall not apply to moments produced by loading on cantilevers. If the negative moment is resisted by a column rigidly framed to the beam or girder, the one-tenth reduction may be used in proportioning the column for the combined axial and bending loading, provided that the unit stress " f_a " due to any concurrent axial load on the member, does not exceed $0.15 "F_a."$

Tension and compression on extreme fibers of unsymmetrical members, except channels, supported as specified in this Section in the region of compression stress

$$F_b = 0.60F_y$$

Tension and compression on extreme fibers of box-type members whose proportions do not meet the provisions of a compact section, but do conform to the provisions of Section 2706

$$F_b = 0.60F_y$$

Tension on extreme fibers of rolled shapes, built-up members and plate girders not classified as compact sections

$$F_b = 0.60F_y$$

Compression on extreme fibers of rolled shapes, plate girders and built-up members not classified as compact sections and having an axis of symmetry in the plane of their web (other than box-type beams and girders) the larger value computed by Formulas (4)¹ and (5), but not more than $0.60F_y$

$$F_b = \left[1.0 - \frac{(l/r)^2}{2C_c^2 C_b} \right] 0.60F_y \quad \text{Formula (4)}$$

$$F_b = \frac{12,000,000}{ld/A_f} \quad \text{Formula (5)}$$

where " l " is the unbraced length of the compression flange; " r " is the radius of gyration of a tee section comprising the compression flange plus one-sixth of the web area, about an axis in the plane of the web; " A_f " is the area of the compression flange; " C_c " is defined in Section 2702 (b) 3 and " C_b " is equal to

$$C_b = 1.75 - 1.05 \left(\frac{M_1}{M_2} \right) + 0.3 \left(\frac{M_1}{M_2} \right)^2$$

but not more than 2.3 taken about the strong axis of the member, and where " M_1/M_2 ," the ratio of end moments, is positive when " M_1 " and " M_2 " have the same sign single curvature

¹Where " l/r " is less than 40 stress reduction in Formula (4) may be neglected.

**Allowable
Unit Stresses
(Continued)**

bending) and negative when they are of opposite sign (reverse curvature bending). When the bending moment point within an unbraced length is larger than that at the ends of this length the ratio " M_1/M_2 " shall be taken as 1. See Section 2707 for further limitation in plate girder stress.

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

$$F_b = 0.60F_y$$

Tension and compression on extreme fibers of pins

$$F_b = 0.90F_y$$

Tension and compression on extreme fibers of rectangular bearing plates

$$F_b = 0.75F_y$$

5. **Bearing (on contact area).** Milled surfaces in bearing stiffeners and pins in reamed, drilled or bored holes, pounds per square inch²

$$F_p = 0.90F_y$$

Expansion rollers and rockers, pounds per linear inch

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

where " d " is the diameter of roller or rocker in inches.

(c) **Rivets and Bolts.** 1. The allowable tension and stresses on rivets and bolts based on gross area shall not exceed the values set forth in Table No. 27-A.

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

$$F_p = 1.35F_y$$

WHERE:

F_p = Allowable bearing stress on the projected bearing area with a maximum value not to exceed 45,000 pounds per square inch.

F_y = Yield point of the connected part.

(d) **Welds.** 1. **Fillet, plug, slot and partial penetration groove welds.** The allowable tensile or shear stress in the throat area of fillet, plug, slot and partial penetration groove welds shall not exceed the values specified in this Section.

Stress in fillet, plug and slot welds, tension stress, shall be based on the axis of partial penetration groove welds and in such welds, when made with A233 Class E60 series electrodes or by submerged arc welding Grade SAW-1 on all or with A233 Class E70 series electrodes or by submerged arc welding Grade SAW-2 on A7 and A373 steels.....

¹When parts in contact have different yield points, " F_y " shall be the smaller value.

ess in fillet, plug and slot welds, tension stress trans-
to the axis of partial penetration groove welds and shear
h welds, when made with A233 Class E70 series elec-
s or by submerged arc welding Grade SAW-2 on A36,
and A441 steels.....15,800

Allowable
Unit Stresses
(Continued)

Groove welds. The full stresses allowed by Section
(b) for the connected material shall apply to complete
ration groove welds stressed in tension, compression,
ng, shear and bearing and to partial penetration groove
stressed in compression, in bearing or in tension parallel
e axis of the weld. See U.B.C. Standard No. 27-6-64 for
odes and submerged arc welding process to be employed
rious grades of steel.

Effective areas of weld metal. The effective area of
und fillet welds shall be considered as the effective length
e weld times the effective throat thickness.

e effective shearing area of plug and slot welds shall be
lered as the nominal cross-sectional area of the hole or
n the plane of the faying surface.

e effective area of fillet welds in holes and slots shall be
uted as above specified for fillet welds, using for effec-
length, the length of centerline of the weld through the
of the plane through the throat. However, in the case
erlapping fillets, the effective area shall not exceed the
ial cross-sectional area of the hole or slot, in the plane
e faying surface.

e effective length of a fillet weld shall be the over-all
l of full-size fillet including returns.

e effective length of a butt weld shall be the width of
art joined.

e effective throat thickness of a fillet weld shall be the
st distance from the root to the face of the diagram-
weld.

e effective throat thickness of a complete penetration
weld [i.e., a butt weld conforming to the requirements
tion 2720 (f)] shall be the thickness of the thinner part

e effective throat thickness of single-V or single-bevel
e welds having no root opening and having partial
ation into their joints shall be one-fourth inch ($\frac{1}{4}$ ")
an the depth of the "V" or bevel groove. The effective
thickness of single "J" or single "U" groove welds hav-
root opening and having partial penetration into their
shall be the depth of the "J" or "U" groove. The effec-
throat thickness of any of these partial penetration groove
shall be not less than $\sqrt{t_t/6}$, where " t_t " is the thickness
thinner part connected by the weld.

Cast Steel and Steel Forgings. The allowable stress for
cel and steel forgings shall not exceed the values speci-
Section 2702 (h).

**Allowable
Unit Stresses
(Continued)**

(f) **Wind and Seismic Stresses.** Allowable stresses may be increased one-third above the values specified in Sections 2702 (b), 2702 (c), 2702 (d), 2702 (e) and 2703 (a) when produced by wind or seismic loading, acting alone or in combination with the design dead and live loads, provided the required section computed on this basis is not less than that required for the design dead and live load and impact, computed without the one-third stress increase, nor less than that as set forth in U.B.C. Standard No. 27-3-64.

EXCEPTION: The one-third increase for wind or seismic forces is not permitted in addition to the increases allowed for compact sections continuous over supports or rigidly framed to columns as specified in Section 2702 (b) 4.

**Combined
Stresses**

Sec. 2703. (a) Axial Compression and Bending. Members subject to both axial compression and bending stresses shall be proportioned to satisfy the following requirements:

WHERE:

$$\frac{f_a}{F_a} \leq 0.15$$

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1.0 \quad \text{Formula (6)}$$

WHERE:

$$\frac{f_a}{F_a} > 0.15$$

$$\frac{f_a}{F_a} + \frac{C_m f_b}{\left(1 - \frac{f_a}{F'_e}\right) F_b} \leq 1.0 \quad \text{Formula [7 (a)]}$$

and, in addition, at points braced in the plane of bending

$$\frac{f_a}{0.6 F_y} + \frac{f_b}{F_b} \leq 1.0 \quad \text{Formula [7 (b)]}$$

C_m = A coefficient whose value shall be taken as follows:

1. For compression members in frames subject to joint translation (sidesway)
" C_m " = 0.85.
2. For restrained compression members in frames braced against joint translation and not subject to transverse loading between their supports in the plane of bending,
" C_m " = $0.6 + 0.4 M_1/M_2$, but not less than 0.4, where " M_1/M_2 " is the ratio of the smaller to the larger moments at the ends of

that portion of the member, unbraced in the plane of bending, under consideration. " M_1/M_2 " is positive when the member is bent in single curvature and negative when it is bent in reverse curvature.

**Combined
Stresses
(Continued)**

3. For compression members in frames braced against joint translation in the plane of loading and subjected to transverse loading between their supports, the value of " C_m " may be determined by rational analysis. However, in lieu of such analysis, the following values may be used: (a) for members whose ends are restrained, " C_m " = 0.85; (b) for members whose ends are unrestrained, " C_m " = 1.

(b) **Axial Tension and Bending.** Members subject to both axial tension and bending stresses shall be proportioned to satisfy the requirements of Formula [7 (b)] where " f_b " and " F_b " are taken, respectively, as the computed and permitted bending tensile stress. However, the computed compressive stress, taken alone, shall not exceed the value permitted by Formula (4) and Formula (5).

(c) **Shear and Tension.** Rivets and bolts subject to combined shear and tension shall be so proportioned that the tension stress produced by the force shall not exceed the following:

For A141 rivets $F_t = 28,000 - 1.6f_v \leq 20,000$

For A195 and A406 rivets.... $F_t = 38,000 - 1.6f_v \leq 27,000$

TABLE NO. 27-A—ALLOWABLE STRESSES FOR RIVETS AND BOLTS

DESCRIPTION OF FASTENER	TENSION (F_t)	SHEAR (F_v)	
		Friction- Type Connections	Bearing- Type Connections
A141 hot-driven rivets	20,000		15,000
A195 and A406 hot-driven rivets	27,000		20,000
A307 bolts and threaded parts of A7 and A373 steel	14,000		10,000
Threaded parts of other steels	$0.40F_y$		$0.30F_y$
A325 bolts when threading is <i>not</i> excluded from shear planes	40,000	15,000	15,000
A325 bolts when threading is ex- cluded from shear planes	40,000	15,000	22,000
A354, Grade BC, bolts when threading is <i>not</i> excluded from shear planes	50,000	20,000	20,000
A354, Grade BC, when threading is excluded from shear planes	50,000	20,000	24,000

Note: There are no bearing stresses in friction-type connections.

Combined
Stresses
(Continued)

For A307 bolts $F_t = 20,000 - 1.6f_v \leq 14,000$
For A325 bolts in bearing-
type joints $F_t = 50,000 - 1.6f_v \leq 40,000$
For A354, Grade BC, bolts
in bearing-type joints..... $F_t = 60,000 - 1.6f_v \leq 50,000$
Where the shear stress " f_v " produced by the same force shall
not exceed the allowable value for shear specified in Section
2702 (c).

For bolts used in friction-type joints, the shear stress al-
lowed in Section 2702 (c) shall be reduced so that:
For A325 bolts $F_v \leq 15,000 (1 - f_t A_b / T_b)$
For A354, Grade BC, bolts.... $F_v \leq 20,000 (1 - f_t A_b / T_b)$
where " f_t " is the tensile stress due to applied load and " T_b " is
the proof load of the bolt.

Stress Reversal

Sec. 2704. Members or connections which are subjected
to a variation or reversal of stress shall be designed as set forth
in U.B.C. Standard No. 27-3-64.

Slenderness
Ratios

Sec. 2705. (a) **Definition.** In determining the slenderness
ratio of an axially loaded compression member except as pro-
vided by Formula (3) the length " l " shall be taken as its
effective length " Kl " and " r " the corresponding radius of
gyration.

(b) **Sidesway Prevented.** In frames where lateral stability
is provided, and in trusses, the effective length factor " K " for
the compression members shall be taken as unity.

EXCEPTION: A " K " value of less than one may be used
where substantiating data justifies such a reduction.

(c) **Sidesway Not Prevented.** The effective length of " Kl "
compression members in a frame which depends upon its own
bending stiffness for lateral stability shall be determined by
a rational method and shall not be less than the actual un-
braced length.

(d) **Maximum Ratios.** The slenderness ratio of compres-
sion members shall not exceed 200.

The slenderness ratio of tension members, other than rods,
shall not exceed:

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

Width-Thickness
Ratios

Sec. 2706. (a) **Projecting Compression Elements.** Project-
ing compression elements shall have width-to-thickness ratios
not greater than the following:

- Single-angle struts; double-angle struts with
separators $2400 / \sqrt{F_v}$
- Struts comprising double angles in contact;
angles or plates projecting from girders, col-
umns or other compression members; com-

pression flanges of beams; stiffeners on plate girders	3000/ $\sqrt{F_y}$	Width-Thickness Ratios (Continued)
Stems of tees.....	4000/ $\sqrt{F_y}$	

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

Projecting compression elements may be designed on assumption that a portion of the unsupported width is removed.

(b) **Compression Elements Supported Along Two Edges.** The unsupported width-to-thickness ratios of compression webs cover or diaphragm plates, between the nearest lines of fasteners or welds, or between the roots of the flanges in case of rolled sections, shall not exceed

$$8000$$

$$\sqrt{F_y}$$

EXCEPTIONS: 1. Compression elements supported along two edges may be designed on assumption that a portion of the unsupported width is removed.

2. The net width-to-thickness ratios of cover plates perforated with access holes shall not exceed

$$10,000$$

$$\sqrt{F_y}$$

Sec. 2707. (a) Proportions. Riveted and welded plate girders, cover-plated beams and rolled beams shall be proportioned by the moment of inertia of the gross section. No deduction shall be made for shop or field rivet or bolt holes in either flange, except that in cases where the reduction of the area of either flange by such holes, calculated in accordance with the provisions of Section 2711 (c), exceeds 15 per cent of the gross flange area, the excess shall be deducted.

**Plate Girders
and Rolled Beams**

(b) **Web.** The clear distance between flanges in inches shall not exceed

$$14,000,000 (t)$$

$$\sqrt{F_y(F_y + 16,500)}$$

(c) **Flanges.** The thickness of outstanding parts of flanges shall conform to the requirements of Section 2706.

The ratio of unstiffened cover plate extension on riveted girders beyond the outer row of rivets or bolts to the thickness of the thinnest outside plate shall not exceed

**Plate Girders
and Rolled Beams
(Continued)**

$$\frac{3000}{\sqrt{F_y}}$$

The total cross-sectional area of cover plates of riveted girders shall not exceed 70 per cent of the total flange area. Provision shall be made for stresses resulting from abrupt changes in flange direction and other conditions that introduce stress concentration.

(d) **Flange Development.** Rivets, high strength bolts or welds connecting flange to web, or cover plate to flange, shall be proportioned to resist the total horizontal shear resulting from the bending forces on the girder. The longitudinal distribution of these rivets, bolts or of intermittent welds shall be in proportion to the intensity of the shear. But the longitudinal spacing shall not exceed the maximum permitted, respectively, for compression or tension members in Sections 2715 (c) or 2715 (d). In addition, rivets or welds connecting flange to web shall be proportioned to transmit to the web loads applied directly to the flange except where provision is made to transmit such loads by direct bearing.

Partial length cover plates shall be extended beyond the theoretical cut-off point and the extended portion shall be attached to the beam or girder by rivets, high strength bolts or fillet welds adequate to develop the cover plate's portion of the flexural stresses in the beam or girder at the theoretical cut-off point. In addition, for welded cover plates, the welds connecting the cover plate termination to the beam or girder in the length "a'," defined below, shall be adequate to develop the cover plate's portion of the flexural stresses in the beam or girder at the distance "a" from the end of the cover plate. The length "a'," measured from the end of the cover plate, shall be:

1. A distance equal to the width of the cover plate when there is a continuous weld equal to or larger than three-fourths of the plate thickness across the end of the plate and continued welds along both edges of the cover plate in the length "a'."
2. A distance equal to one and one-half times the width of the cover plate when there is a continuous weld smaller than three-fourths of the plate thickness across the end of the plate and continued welds along both edges of the cover plate in the length "a'."
3. A distance equal to two times the width of the cover plate when there is no weld across the end of the plate but continuous welds along both edges of the cover plate in the length "a'."

(e) **Stiffeners.** Bearing stiffeners shall be placed in pairs at unframed ends on the webs of plate girders and, where required, at points of concentrated loads. Such stiffeners shall have a close bearing against the flange, or flanges, through

**Plate Girders
and Rolled Beams
(Continued)**

which they receive their loads or reactions, and shall extend approximately to the edge of the flange plates or flange angles. They shall be designed as columns subject to the provisions of Section 2702 (b) 3, assuming the column section to comprise the pair of stiffeners and a centrally located strip of the web whose width is equal to not more than 25 times its thickness at interior stiffeners or a width equal to not more than 12 times its thickness when the stiffeners are located at the end of the web. The effective length shall be taken as not less than three-fourths of the length of the stiffeners in computing the ratio " l/r ." Only that portion of the stiffener outside of the angle fillet or the flange-to-web welds shall be considered effective in bearing.

The largest average web shear " f_v " in any panel between stiffeners shall not exceed the value given by Formula (8) or (9), as applicable.

WHEN: " C_v " is less than 1.0

$$F_v = \frac{F_y}{2.89} \left[C_v + \frac{1 - C_v}{1.15\sqrt{1 + (a/h)^2}} \right] \quad \text{Formula (8)}$$

WHEN:

" C_v " is more than 1.0 or when intermediate stiffeners are omitted;

$$F_v = \frac{F_y (C_v)}{2.89} \quad \text{Formula (9)}$$

but not to exceed

$$F_v = .4F_y$$

WHERE:

$$C_v = \frac{45,000,000k}{F_y (h/t)^2}, \text{ when } "C_v" \text{ is less than } 0.8.$$

$$C_v = \frac{6000}{h/t} \sqrt{\frac{k}{F_y}}, \text{ when } "C_v" \text{ is more than } 0.8.$$

$$k = 4.00 + \frac{5.34}{(a/h)^2}, \text{ when } "a/h" \text{ is less than } 1.0.$$

$$k = 5.34 + \frac{4.00}{(a/h)^2}, \text{ when } "a/h" \text{ is more than } 1.0.$$

When " a/h " is more than three, its value shall be taken as infinity. In this case Formula (9) reduces to Formula (10) and $k = 5.34$.

Intermediate stiffeners are not required when the ratio " h/t " is less than 260 and the maximum web shear stress " f_v " is less than that permitted by Formula (10).

**Plate Girders
and Rolled Beams
(Continued)**

The spacing of intermediate stiffeners, when stiffeners are required, shall be such that the web shear stress will not exceed the value for " F_v " given by Formulas (9) or (10), as applicable and the ratio " a/h " shall not exceed

$$\left(\frac{260}{h/t} \right)^2 \text{ nor } 3.0.$$

The spacing between stiffeners at end panels and panels containing large holes shall be such that the smaller panel dimension, " a " or " h ," shall not exceed

$$\frac{11,000t}{\sqrt{f_v}}$$

The gross area, in square inches, of intermediate stiffeners spaced in accordance with Formula (8) shall be not less than that computed by Formula (10).

$$A_{st} = \frac{1 - C_v}{2} \left[\frac{a}{h} - \frac{(a/h)^2}{\sqrt{1 + (a/h)^2}} \right] Y D h t \quad \text{Formula (10)}$$

WHERE:

C_v is as defined in Section 2707 (e).

Y = yield point of web steel/yield point of stiffener steel.

D = 1.0 for stiffeners furnished in pairs

= 1.8 for single angle stiffeners.

= 2.4 for single plate stiffeners.

When the greatest shear stress " f_v " in a panel is less than that permitted by Formula (8) this gross area requirement may be reduced in like proportion.

The moment of inertia of a pair of stiffeners, or a single stiffener, with reference to an axis in the plane of the web, shall not be less than

$$\left(\frac{h}{50} \right)^4$$

Intermediate stiffeners may be stopped short of the tension flange a distance not to exceed four times the web thickness, provided bearing is not needed to transmit a concentrated load or reaction. When single stiffeners are used they shall be attached to the compression flange, if it consists of a rectangular plate, to resist any uplift tendency due to torsion in the plate. When lateral bracing is attached to a stiffener, or a pair of stiffeners, these, in turn, shall be connected to the compression flange to transmit one per cent of the total flange stress, unless the flange is composed only of angles.

Intermediate stiffeners required by the provisions of Section 2707 (e) shall be connected for a shear transfer of not less than:

**Plate Girders
and Rolled Beams
(Continued)**

$$f_{rs} = h \sqrt{\left(\frac{F_y}{3400} \right)^3}$$

WHERE:

F_y = yield point of web steel.

This shear transfer may be reduced in the same proportion that the largest computed shear stress " f_v " in the adjacent panels is less than that permitted by Formula (8). However, rivets and welds in intermediate stiffeners which are required to transmit to the web an applied concentrated load or reaction shall be proportioned for not less than the applied load or reaction.

Rivets connecting stiffeners to the girder web shall be spaced not more than twelve inches (12") on center. If intermittent fillet welds are used, the clear distance between welds shall not be more than 16 times the web thickness nor more than ten inches (10").

(f) **Reduction in Flange Stress.** When the web depth to thickness ratio exceeds $24,000/\sqrt{F_b}$, the maximum stress in the compression flange shall not exceed

$$F'_b \leq F_b \left[1.0 - 0.0005 \frac{A_m}{A_f} \left(\frac{h}{t} - \frac{24,000}{\sqrt{F_b}} \right) \right] \quad \text{Formula (11)}$$

(g) **Combined Shear and Tension Stress.** Plate girder webs subject to a computed average shear stress in excess of that permitted by Formula (9) shall be so proportioned that the bending tensile stress, due to moment in the plane of the girder web, shall not exceed

$$0.6F_y \text{ nor } \left(0.825 - 0.375 \frac{f_v}{F_v} \right) F_y \quad \text{Formula (12)}$$

(h) **Splices.** Butt welded splices in plate girders and beams shall be complete penetration groove welds and shall develop the full strength of the smaller spliced section. Other types of splices in cross sections of plate girders and in beams, shall develop the strength required by the stresses, at the point of splice, but in no case less than 50 per cent of the effective strength of the material spliced.

(i) **Horizontal Forces.** The flanges of plate girders supporting cranes or other moving loads shall be proportioned to resist the horizontal forces produced by such loads.

The lateral force on crane runways shall be 20 per cent of the sum of the weights of the lifted load and of the crane trolley, applied at the top of rail, one-half on each side of the runway; and shall be considered as acting in either direction normal to the runway rail.

**Plate Girders
and Rolled Beams
(Continued)**

The longitudinal force shall be 10 per cent of the maximum wheel loads of the crane applied at the top of rail.

(j) **Web Crippling.** Webs of beams and welded plate girders shall be so proportioned that the compressive stress at the web toe of the fillets, resulting from concentrated loads not supported by bearing stiffeners, does not exceed the value specified in Section 2702 (b).

3. The compressive stress at the web top of the fillets shall be computed using the following formulas:

For interior loads: Formula (13)

$$\frac{R}{t(N + 2k)}$$

For end-reactions: Formula (14)

$$\frac{R}{t(N + k)}$$

WHERE:

N = length of bearing in inches (not less than "k" for end reactions).

Bearing stiffeners shall be provided where the compressive stress as determined by Formulas 13 and 14 exceeds the allowable stress specified in Section 2702 (b) 3.

Webs of welded plate girders shall also be so proportioned or stiffened that the sum of the compression stresses resulting from concentrated and distributed loads, bearing directly on or through a flange plate, upon the compression edge of the web plate, and not supported directly by bearing stiffeners do not exceed the following:

When the flange is restrained against rotation,

$$\left[5.5 + \frac{4}{(a/h)^2} \right] \frac{10,000,000}{(h/t)^2} \quad \text{Formula (15)}$$

When the flange is not restrained against rotation,

$$\left[2 + \frac{4}{(a/h)^2} \right] \frac{10,000,000}{(h/t)^2} \quad \text{Formula (16)}$$

These stresses shall be computed as follows: Concentrated loads and loads distributed over partial length of a panel shall be divided by the product of the web thickness and the girder depth or the length of panel in which the load is placed, whichever is the lesser panel dimension.

Any other distributed loading, in pounds per linear inch of length, shall be divided by the web thickness.

**Composite
Construction**

Sec. 2708. (a) **Definition.** Composite construction shall consist of steel beams or girders supporting a reinforced con-

**Composite
Construction
(Continued)**

crete slab, so interconnected that the beam and slab act together to resist bending. When the slab extends on both sides of the beam, the effective width of the concrete flange shall be taken as not more than one-fourth of the span of the beam, and its effective projection beyond the edge of the beam shall not be taken as more than one-half the clear distance to the adjacent beam, nor more than eight times the slab thickness. When the slab is present on only one side of the beam, the effective width of the concrete flange shall be taken as not more than one-twelfth of the beam span, nor six times its thickness nor one-half the clear distance to the adjacent beam.

Beams totally encased two inches (2") or more on their sides and soffit in concrete poured integrally with the slab may be assumed to be interconnected to the concrete by natural bond, without additional anchorage, provided the top of the beam is not less than one and one-half inches (1½") below the top and two inches (2") above the bottom of the slab, and provided that the encasement has adequate mesh or other reinforcing steel throughout the depth and across the soffit of the beam. When shear connectors are provided in accordance with Section 2708 (d), encasement of the beam to achieve composite action is not required.

(b) **Design Assumptions.** Encased beams shall be proportioned to support unassisted all dead loads applied prior to the hardening of the concrete except where these loads are supported temporarily on shoring. The beams acting in conjunction with the slab shall support all dead and live loads applied after hardening of the concrete, without exceeding a computed bending stress of $0.66F_y$, where " F_y " is the yield point of the steel beam. The bending stress produced by loads after the concrete has hardened shall be computed on the basis of the moment of inertia of the composite section. Concrete tension stresses below the neutral axis of the composite section shall be neglected. Alternatively, the steel beam may be proportioned to resist unassisted the moment produced by all loads, live and dead, using a bending stress equal to $0.76F_y$, in which case temporary shoring is not required.

When shear connectors are used in accordance with Section 2708 (d) the composite section shall be proportioned to support all of the loads without exceeding the allowable stress prescribed in Section 2702 (b) 4 as applicable. The moment of inertia " I_{tr} " of the composite section shall be computed in accordance with the elastic theory. Concrete tension stresses below the neutral axis of the composite section shall be neglected. The compression area of the concrete above the neutral axis shall be treated as an equivalent area of steel by dividing it by the modular ratio " n ."

For construction without temporary shoring the value of the section modulus of the transformed composite section used in stress calculations shall not exceed

**Composite
Construction
(Continued)**

$$S_{tr} = \left(1.35 + 0.35 \frac{M_L}{M_D} \right) S_s \quad \text{Formula (17)}$$

provided that the steel beam alone, supporting the loads before the concrete has hardened, is not stressed to more than the applicable bending stress given in Section 2702 (b).

(c) **End Shear.** The web and the end connections of the steel beam shall be designed to carry the total dead and live load.

(d) **Shear Connectors.** The horizontal shear between the steel beam and concrete slab shall be transferred by shear connectors welded to the beam and embedded in the concrete except as specified in Section 2708 (a). The total horizontal shear to be resisted between the point of maximum positive moment and each end of simple span steel beams and between the point of maximum positive moment and a point of contraflexure in continuous span beams shall be the smaller value obtained using the following formulas:

$$V_h = \frac{0.85f'_c A_c}{2} \quad \text{Formula (18)}$$

AND

$$V_h = \frac{A_s F_y}{2} \quad \text{Formula (19)}$$

The number of connectors resisting the shear obtained from Formulas (18) and (19) shall be not less than that determined by the following formula:

$$\frac{V_h}{q}$$

Shear connectors, their method of attachment and allowable shear value shall be as set forth in U.B.C. Standard No. 27-8-64. Shear connectors not provided for in U.B.C. Standard No. 27-8-64 shall be approved by the Building Official.

The required number of shear connectors may be spaced uniformly between the sections of maximum and zero moment.

Shear connectors shall have at least one inch (1") of concrete cover in all directions.

**Simple and
Continuous Spans**

Sec. 2709. (a) Simple Spans. Beams, girders and trusses shall be designed on the basis of simple spans whose effective length is equal to the distance between the centers of gravity of the members to which they deliver their end reactions.

(b) **Continuous Spans.** Beams, girders and trusses designed on the assumption of full or partial end restraint shall be

designed to carry the shears and moments caused by continuity without exceeding the unit stresses prescribed in Section 2702 (b).

Sec. 2710. Horizontal framing members shall be designed for the deflection criteria and ponding requirements specified in Section 2307. **Deflections**

Sec. 2711. (a) General. The gross section of a member at any point shall be determined by summing the products of the thickness and the gross width of each element as measured normal to the axis of the member. The net section shall be determined by substituting for the gross width the net width computed as specified in Section 2711 (b). **Gross and Net Sections**

Tension members shall be designed on the basis of net section. Compression members shall be designed on the basis of gross section. Beams and girders shall be designed in accordance with Section 2707.

(b) Net Width. The net width of a section containing a diagonal or zigzag chain of holes shall be obtained by deducting from the gross width the sum of the diameters of all the holes in the chain, and adding, for each gage space in the chain, the quantity

$$\frac{s^2}{4g}$$

The critical net section is obtained from that chain of holes which gives the least net width. The net section through a hole shall not exceed 85 per cent of the corresponding gross section.

Weld metal in plug or slot welds shall not be considered as adding to the net area.

(c) Angles. The gross width of angles shall be the sum of the widths of the legs less the thickness. The gauge for holes in opposite legs shall be the sum of the gauges from back of angles less the thickness.

(d) Size of Holes. In computing net area the diameter of a rivet or bolt hole shall be taken as one-eighth inch ($\frac{1}{8}$ ") greater than the nominal diameter of the rivet or bolt.

(e) Pin-connected Members. Eyebars shall be of uniform thickness without reinforcement at the pinholes. They shall have "circular" heads in which the periphery of the head beyond the pinhole is concentric with the pinhole. The radius of transition between the circular head and the body of the eyebar shall be equal to or greater than the diameter of the head.

The width of the body of the eyebar shall not exceed eight times its thickness, and the thickness shall not be less than

**Gross and
Net Sections
(Continued)**

one-half inch ($\frac{1}{2}$ "). The net section of the head through the pinhole transverse to the axis of the eyebar shall not be less than 1.33 nor more than 1.50 times the cross-sectional area of the body of the eyebar. The diameter of the pin shall not be less than seven-eighths the width of the body of the eyebar. The diameter of the pinhole shall not be more than one-thirty-second inch ($\frac{1}{32}$ ") greater than the diameter of the pin.

The minimum net section across the pinhole, transverse to the axis of the member, in pin-connected plates and built-up members shall be determined using the allowable stress specified in Section 2702 (b) 1. The net section beyond the pinhole, parallel to the axis of the member, shall not be less than two-thirds of the net section across the pinhole. The corners beyond the pinhole may be cut at 45 degrees to the axis of the member provided the net section beyond the pinhole on a plane perpendicular to the cut is not less than that required beyond the pinhole parallel to the axis of the member. The parts of members built up at the pinhole shall be attached to each other by sufficient fasteners to support the stress delivered to them by the pin.

The distance transverse to the axis of a pin-connected plate or any separated element of a built-up member from the edge of the pinhole to the edge of the member or element shall not exceed four times the thickness at the pinhole. The diameter of the pin shall preferably not be less than five times the thickness of the member or separated element at the pinhole. If a smaller size is used, the bearing stress shall not exceed the value specified in Section 2702 (b) 5. The diameter of the pinhole shall not be more than one-thirty-second inch ($\frac{1}{32}$ ") greater than the diameter of the pin.

Connections

Sec. 2712. (a) Minimum Connections. Connections shall be designed for all tributary forces and shall be capable of supporting not less than 6000 pounds.

EXCEPTION: Lacing, sag bars and girts may be designed only for tributary forces.

(b) Eccentric Connections. Members and their connections shall be designed for eccentricity where the gravity axis of the connected members do not meet at a point.

(c) Placement of Rivets, Bolts and Welds. Except as hereinafter provided, the rivets, bolts or welds at the ends of any member transmitting axial stress into that member shall have their centers of gravity on the gravity axis of the member unless provision is made for the effect of the resulting eccentricity. Except in members subject to repeated variation in stress as defined in U.B.C. Standard No. 27-3-64, disposition of fillet welds to balance the forces about the neutral axis or axes for end connections of single angle, double angle, and

similar type members is not required. Eccentricity between the gravity axes of such members and the gauge lines for their riveted or bolted end connections may be neglected.

**Connections
(Continued)**

(d) **Unrestrained Members.** Beam, girder or truss connections may be proportioned for the reaction shears only where the connections are flexible.

Flexible connections shall permit the ends of the beam to rotate sufficiently to accommodate its deflection by providing for a horizontal displacement of the top flange determined as follows:

$$e = 0.007d, \text{ when the beam is designed for full uniform load and for live load deflection not exceeding one three-hundred-sixtieth of the span.}$$

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

WHERE:

- e = the horizontal displacement of the end of the top flange, in the direction of the span, in inches.
- f_b = the flexural unit stress in the beam at mid-span, in pounds per square inch.
- d = the depth of the beam, in inches.
- L = the span of the beam, in feet.

(c) **Restrained Members.** Fasteners or welds for end connections of beams, girders and trusses not conforming to the requirements of Section 2712 (d) shall be designed for the combined effect of end reaction shear and tensile or compressive stresses resulting from moment induced by the rigidity of the connection when the member is fully loaded.

(f) **Fillers.** When rivets or bolts carrying computed stress pass through fillers thicker than one-fourth inch ($\frac{1}{4}$ "), except in friction-type connections assembled with high strength bolts, the fillers shall be extended beyond the splice material and the filler extension shall be secured by enough rivets or bolts to distribute the total stress in the member uniformly over the combined section of the member and the filler, or an equivalent number of fasteners shall be included in the connection.

In welded construction, fillers one-fourth inch ($\frac{1}{4}$ ") or more in thickness shall extend beyond the edges of the splice plate and shall be welded to the part on which it is fitted with sufficient weld to transmit the splice plate stress, applied at the surface of the filler as an eccentric load. The welds joining

**Connections
(Continued)**

the splice plate to the filler shall be sufficient to transmit the splice plate stress and shall be long enough to avoid over-stressing the filler along the toe of the weld. Fillers less than one-fourth inch ($\frac{1}{4}$ ") thick shall have edges flush with the edges of the splice plate and the weld size shall be the sum of the size necessary to carry the splice plate stress plus the thickness of the filler plate.

(g) **Connections of Tension and Compression Members in Trusses.** The connections at ends of tension or compression members in trusses shall develop the strength required by the stress, but not less than 50 per cent of the effective strength of the member. Groove welds at the ends of tension or compression members in trusses shall be complete penetration groove welds.

(h) **Compression Members with Bearing Joints.** Where compression members bear on bearing plates, and where tier-building columns are finished to bear, there shall be sufficient rivets, bolts or welds to hold all parts securely in place.

Where other compression members are finished to bear, the splice material and its riveting, bolting or welding shall be arranged to hold all parts in line and shall be proportioned for 50 per cent of the computed stress.

Joints shall be proportioned to resist tension that would be developed by lateral forces acting in conjunction with 75 per cent of the calculated dead load stress and no live load.

(i) **Combination of Welds.** If two or more types of welds are combined in a joint, the effective capacity of each type weld shall be computed with reference to the axis of the group, in order to determine the allowable capacity of the combination.

(j) **Rivets and Bolts in Combination with Welds.** Welds, used in combination with rivets and bolts, shall be considered as carrying the entire load on the connection.

EXCEPTION: Rivets and tightened high strength bolts (friction-type) may share stress in combination with welds for alterations to existing structures, provided the rivets or bolts carry only the existing dead load and the welds are capable of carrying all additional loads.

(k) **High-Strength Bolts (in Friction-type Joints) in Combination with Rivets.** High strength bolts, installed in accordance with the provisions of Section 2713 (a) as friction-type connections, may be considered as sharing the stresses with rivets in a connection.

(l) **Field Connections.** Rivets, high strength bolts or welds shall be used for the following connections:

Column splices in all tier structures two hundred feet (200') or more in height. **Connections (Continued)**

Column splices in tier structures one hundred feet (100') to two hundred feet (200') in height, if the least horizontal dimension is less than 40 per cent of the height.

Column splices in tier structures less than one hundred feet (100') in height, if the least horizontal dimension is less than 25 per cent of the height.

Connections of all beams and girders to columns and of any other beams and girders on which the bracing of columns is dependent, in structures over one hundred and twenty-five feet (125') in height.

Roof-truss splices and connections of trusses to columns, column splices, column bracing, knee braces and crane supports, in all structures carrying cranes of over five-ton capacity.

Connections for supports of running machinery, or of other live loads which produce impact or reversal of stress.

For the purpose of this Section, the height of a tier structure shall be taken as the vertical distance from the curb level to the highest point of the roof beams, in the case of flat roofs, or to the mean height of the gable, in the case of roofs having a rise of more than two and two-thirds in 12. Where the curb level has not been established, or where the structure does not adjoin a street, the mean level of the adjoining land shall be used instead of curb level. Penthouses may be excluded in computing the height of structure.

Sec. 2713. (a) High Strength Bolts. Use of high strength bolts shall conform to the provisions of U.B.C. Standard No. 27-7-64. **Rivets and Bolts**

(b) **Effective Bearing Area.** The effective bearing area of rivets and bolts shall be the diameter multiplied by the length in bearing, except that for countersunk rivets and bolts half the depth of the countersink shall be deducted.

(c) **Long Grips.** Rivets and A307 bolts which carry calculated stress, and the grip of which exceeds five diameters, shall have their number increased one per cent for each additional one-sixteenth inch ($\frac{1}{16}$ ") in the grip.

(d) **Minimum Pitch.** The minimum distance between centers of rivet and bolt holes shall be not less than two and two-thirds times the nominal diameter of the rivet or bolt.

(e) **Minimum Edge Distance.** The minimum distance from the center of a rivet or bolt hole to any edge shall be not less than the values specified in Table No. 27-B.

(f) **Minimum Edge Distance in Line of Stress.** In bearing-type connections of tension members, where there are not more than two fasteners in a line parallel to the direction of

Rivets and Bolts (Continued)

stress, the distance from the center of the end fastener and that end of the connected part toward which the stress is directed for riveted connections shall be not less than the area of the fastener divided by the thickness of the connected part for fasteners in single shear, and twice this distance for fasteners in double shear.

For high strength bolted connections, the end distance shall be one and one-half times the distance specified for riveted connections. The end distance may be decreased proportionally if stress per fastener is less than the value specified in Section 2702 (c). The end distance shall be not less than the value specified in Section 2713 (e).

Section 2713 (e) shall govern when more than two fasteners are provided in the line of stress.

(g) **Maximum Edge Distance.** The maximum distance from the center of any rivet or bolt to the nearest edge of parts in contact with one another shall be 12 times the thickness of the plate, but shall not exceed six inches (6").

Welds

Sec. 2714. (a) General. Welder qualification requirements, welding procedure and welding electrodes shall conform to U.B.C. Standard No. 27-6-64.

(b) **Maximum Effective Size of Fillet Welds.** The maximum size of a fillet weld that may be assumed in the design of a connection shall be such that the stresses in the adjacent base material do not exceed the values allowed in Section 2702 (b). The maximum size that may be used along edges of connected parts shall be:

1. Along edges of material less than one-fourth inch ($\frac{1}{4}$ ") thick, the maximum size may be equal to the thickness of the material.

TABLE NO. 27-B

RIVET OR BOLT DIAMETER (Inches)	MINIMUM EDGE DISTANCE FOR PUNCHED, REAMED OR DRILLED HOLES (Inches)	
	At Sheared Edges	At Rolled Edges of Plates, Shapes or Bars or Gas Cut Edges ¹
$\frac{1}{2}$	$\frac{7}{8}$	$\frac{3}{4}$
$\frac{5}{8}$	$1\frac{1}{8}$	$\frac{7}{8}$
$\frac{3}{4}$	$1\frac{1}{4}$	1
$\frac{7}{8}$	$1\frac{1}{2}$ ²	$1\frac{1}{8}$
1	$1\frac{3}{4}$ ²	$1\frac{1}{4}$
$1\frac{1}{8}$	2	$1\frac{1}{2}$
$1\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{5}{8}$
Over $1\frac{1}{4}$	$1\frac{3}{4} \times$ Diameter	$1\frac{1}{4} \times$ Diameter

¹All edge distances in this column may be reduced one-eighth inch ($\frac{1}{8}$ ") when the hole is at a point where stress does not exceed 25 per cent of the maximum allowed stress in the element.

²These may be one and one-fourth inches ($1\frac{1}{4}$ ") at the ends of beam connection angles.

**Welds
(Continued)**

2. Along edges of material one-fourth inch ($\frac{1}{4}$ ") or more in thickness, the maximum size shall be one-sixteenth inch ($\frac{1}{16}$ ") less than the thickness of the material, unless the weld is especially designated on the drawings to be built out to obtain full throat thickness.

(c) **Length of Fillet Welds.** The minimum effective length of a strength fillet weld shall be not less than four times the nominal size, or else the size of the weld shall be considered not to exceed one-fourth of its effective length.

If longitudinal fillet welds are used alone in end connections of flat bar tension members, the length of each fillet weld shall be not less than the perpendicular distance between them. The transverse spacing of longitudinal fillet welds used in end connections shall not exceed eight inches (8"), except where transverse bending is provided for in the connection.

(d) **Intermittent Fillet Welds.** Intermittent fillet welds may be used to transfer calculated stress across a joint or faying surfaces when the strength required is less than that developed by a continuous fillet weld of the smallest permitted size, and to join components of built-up members. The effective length of any segment of intermittent fillet welding shall be not less than four times the weld size with a minimum of one and one-half inches ($1\frac{1}{2}$ ").

(e) **Lap Joints.** The minimum width of laps on lap joints shall be five times the thickness of the thinner part joined and not less than one inch (1"). Lap joints joining plates or bars subjected to axial stress shall be fillet welded along the edge of both lapped parts except where the deflection of the lapped parts is sufficiently restrained to prevent opening of the joint under maximum loading.

(f) **End Returns of Fillet Welds.** Side or end fillet welds terminating at ends or sides, respectively, of parts or members shall, wherever practicable, be returned continuously around the corners for a distance not less than twice the nominal size of the weld. This provision shall apply to side and top fillet welds connecting brackets, beam seats and similar connections, on the plane about which bending moments are computed.

(g) **Fillet Welds in Holes and Slots.** Fillet welds in holes or slots may be used to transmit shear in lap joints or to prevent the buckling or separation of lapped parts, and to join components of built-up members. Such fillet welds may overlap, subject to the provisions of Section 2711 (g). Fillet welds in holes or slots shall not be considered as plug or slot welds.

(h) **Plug and Slot Welds.** Plug or slot welds may be used to transmit shear in a lap joint or to prevent buckling of lapped parts and to join component parts of built-up members.

The diameter of the holes for a plug weld shall be not less than the thickness of the part containing it plus five-sixteenths

Welds (Continued)

inch ($\frac{5}{16}$ "), rounded to the next greater odd one-sixteenth inch ($\frac{1}{4}$ "), nor greater than two and one-fourth times the thickness of the weld metal.

The minimum center-to-center spacing of plug welds shall be four times the diameter of the hole.

The length of slot for a slot weld shall not exceed 10 times the thickness of the weld. The width of the slot shall be not less than the thickness of the part containing it, plus five-sixteenths inch ($\frac{5}{16}$ "), rounded to the next greater odd one-sixteenth inch ($\frac{1}{8}$ "), nor shall it be greater than two and one-fourth times the thickness of the weld. The ends of the slot shall be semicircular or shall have the corners rounded to a radius not less than the thickness of the part containing it, except those ends which extend to the edge of the part.

The minimum spacing of lines of slot welds in a direction transverse to their length shall be four times the width of the slot. The minimum center-to-center spacing in a longitudinal direction on any line shall be two times the length of the slot.

The thickness of plug or slot welds in material five-eighths inch ($\frac{5}{8}$ ") or less in thickness shall be equal to the thickness of the material. In material over five-eighths inch ($\frac{5}{8}$ ") in thickness, it shall be at least one-half the thickness of the material but not less than five-eighths inch ($\frac{5}{8}$ ").

Built-up Members

Sec. 2715. (a) Open Web Steel Joists. LA and LH Series. Open web steel joists shall be designed as set forth in U.B.C. Standard No. 27-4-64.

(b) Open Box-Type Beams and Grillages. Where two or more rolled beams or channels are used side by side to form a flexural member, they shall be connected together at intervals of not more than five feet (5'). Through-bolts and separators may be used, provided that in beams having a depth of twelve inches (12") or more, no fewer than two bolts shall be used at each separator location. When concentrated loads are carried from one beam to the other, or distributed between the beams, diaphragms having sufficient stiffness to distribute the load shall be riveted, bolted or welded between the beams. Where beams are exposed, they shall be sealed against corrosion of interior surfaces, or spaced sufficiently far apart to permit cleaning and painting.

(c) Compression Members. All parts of built-up compression members and the transverse spacing of their lines of fasteners shall conform to the requirements of Sections 2705 and 2709.

At the ends of built-up compression members bearing on base plates or milled surfaces, all components in contact shall be connected by rivets or bolts spaced longitudinally not more than four diameters apart for a distance equal to one and one-half times the maximum width of the member, or by continuous welds having a length not less than the maximum width of the member.

**Built-up Members
(Continued)**

The longitudinal spacing for intermediate rivets, bolts or intermittent welds in built-up members shall be adequate to provide for the transfer of calculated stress. The spacing of connectors for outside plates of built-up compression members shall not exceed the values determined by the following formulas:

When rivets or bolts are provided on all gauge lines at each section, or when intermittent welds are provided along the edges of the components

$$\frac{4000}{\sqrt{F_y}}$$

but not more than twelve inches (12").

When rivets or bolts are staggered

$$\frac{6000t}{\sqrt{F_y}}$$

but not more than eighteen inches (18").

WHERE:

t = thickness of thinner outside plate in inches.

The maximum longitudinal spacing of rivets, bolts or intermittent welds connecting two rolled shapes in contact with one another shall not exceed twenty-four inches (24").

Compression members composed of two or more rolled shapes separated by intermittent fillers shall be connected at intervals such that the slenderness ratio " l/r " of either shape, between the fasteners, does not exceed the governing slenderness ratio of the built-up member. The least radius of gyration " r " shall be used in computing the slenderness ratio of each component part.

Open sides of compression members built up from plates or shapes shall be provided with lacing having tie plates at each end, and at intermediate points if the lacing is interrupted. In main members carrying calculated stress the end tie plates shall have a length of not less than the distance between the lines of rivets, bolts or welds connecting them to the components of the member. Intermediate tie plates shall have a length not less than one-half of this distance. The thickness of tie plates shall be not less than one-fiftieth of the distance between the lines of rivets, bolts or welds connecting them to the segments of the members. In riveted and bolted construction the pitch in tie plates shall be not more than six diameters and the tie plates shall be connected to each segment by at least three fasteners. In welded construction, the welding on each line connecting a tie plate shall aggregate not less than one-third the length of the plate.

Lacing, including flat bars, angles, channels or other shapes employed as lacing, shall be so spaced that the ratio " l/r " of the flange included between their connections shall not exceed

**Built-up Members
(Continued)**

the governing ratio for the member as a whole. Lacing shall be proportioned to resist a shearing stress normal to the axis of the member equal to two per cent of the total compressive stress in the member. The ratio " l/r " for lacing bars arranged in single systems shall not exceed 140. For double lacing this ratio shall not exceed 200. Double lacing bars shall be joined at their intersections. In determining the required section for lacing bars, Formula (1) or (3) shall be used, " l " being taken as the unsupported length of the lacing bar between rivets or welds connecting it to the components of the built-up member for single lacing and 70 per cent of that distance for double lacing. The inclination of lacing bars to the axis of the member shall be not less than 60 degrees for single lacing and 45 degrees for double lacing. When the distance between the lines of rivets or welds in the flanges is more than fifteen inches (15"), the lacing shall be double or be made of angles.

Tie plates and lacing bars are not required where the open sides of built-up compression members are enclosed with cover plates perforated with access holes. The net width of such plates across holes, as defined in Section 2706 (b), is assumed to resist axial stress, provided that: the width to thickness ratio conforms to the requirements of Section 2706 (b); the ratio of length, in direction of stress to width of hole does not exceed two; the clear distance between holes in the direction of stress is not less than the transverse distance between nearest lines of connecting rivets, bolts or welds; and the periphery of the holes at all points has a minimum radius of one and one-half inches ($1\frac{1}{2}$ ").

(d) **Tension Members.** The longitudinal spacing of rivets, bolts and intermittent fillet welds connecting a plate and a rolled shape in a built-up tension member, or two plate components, shall not exceed 24 times the thickness of the thinner plate nor twelve inches (12"). The longitudinal spacing of rivets, bolts and intermittent welds connecting two or more shapes in a tension member shall not exceed twenty-four inches (24"). Tension members composed of two or more shapes or plates separated by intermittent fillers shall be connected at intervals such that the slenderness ratio of either component between the fasteners does not exceed 240.

Either perforated cover plates or tie plates without lacing may be used on the open sides of built-up tension members. Tie plates shall have a length not less than two-thirds the distance between the lines of rivets, bolts or welds connecting them to the components of the member. The thickness of such tie plates shall not be less than one-fiftieth of the distance between these lines. The longitudinal spacing of rivets, bolts or intermittent welds at tie plates shall not exceed six inches (6"). The spacing of tie plates shall be such that the slenderness ratio of any component in the length between tie plates will not exceed 240.

Sec. 2716. (a) General. Horizontal framing members shall be designed for the deflection criteria and ponding requirements specified in Section 2307. **Camber**

(b) **Trusses and Girders.** Trusses of eighty feet (80') or greater span shall be cambered for the dead load deflection. Crane girders of seventy-five feet (75') or greater span shall be cambered for the dead plus half the live load deflection.

Sec. 2717. Adequate provision shall be made for expansion and contraction appropriate to the service conditions of the structure. **Expansion**

Sec. 2718. (a) Loads. Adequate provision shall be made to transfer the column loads, and moments if any, to the footings and foundations. **Column Bases**

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

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

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

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

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

Sec. 2719. Anchor bolts shall be designed to provide resistance to all conditions of tension and shear at the bases of columns, including the net tensile components of any bending moments which may result from fixation or partial fixation of columns. **Anchor Bolts**

Sec. 2720. The fabrication, erection and painting of structural steel shall conform to U.B.C. Standard No. 27-2-64. **Fabrication**

Sec. 2721. (a) Scope. Subject to the requirements specified in this Section, simple or continuous beams, one- and two-story rigid frames and similar portions of structures rigidly constructed so as to be continuous over at least one interior support may be proportioned on the basis of their maximum strength, otherwise known as plastic design. This strength, as deter- **Plastic Design**

Plastic Design
(Continued)

mined by rational analysis, shall not be less than that required to support 1.70 times the live load plus dead load for simple and continuous beams. For continuous frames it shall not be less than 1.85 times the live load plus dead load, nor 1.40 times these loads acting in conjunction with 1.40 times the wind or earthquake forces.

Connections joining a portion of a structure designed on the basis of plastic behavior with a portion not so designed need be no more rigid than seat-and-cap angle or standard web connections.

Where plastic design is used as the basis for proportioning continuous beams and structural frames, the provisions relating to allowable stress contained in the other Sections of this Chapter are waived. The provisions of this Chapter shall apply except as modified by this Section.

Crane runways shall not be designed continuous over interior vertical supports on the basis of maximum strength. Rigid frame bents supporting crane runways may be considered as coming within the scope of this Section.

(b) **Material.** Structural steel shall conform to U.B.C. Standard No. 27-1-64.

(c) **Columns.** The slenderness ratio " l/r " shall not exceed 120 in the plane of bending for columns which develop a plastic hinge at ultimate loading. The slenderness ratio of columns regulated by Formula (21) shall not exceed 100. The maximum axial load " P " at ultimate loading shall not exceed six-tenths times the plastic axial load " P_y ."

Columns in continuous frames, where sidesway is not prevented by diagonal bracing, by attachment to an adjacent structure having ample lateral stability or by floor slabs or roof decks secured horizontally by walls or bracing systems parallel to the plane of the continuous frames, shall be so proportioned that

$$\frac{2P}{P_y} + \frac{l}{70r} \leq 1.0 \quad \text{Formula (20)}$$

Except as otherwise provided in this Section, " M_o/M_p ," the ratio of allowable end moment to the full plastic bending strength of columns and other axially loaded members, shall not exceed the value given by the following formulas:

Case I. For columns bent in double curvature by moments producing plastic hinges at both ends of the columns

WHERE:

$$\frac{P}{P_y} \leq .15$$

$$\frac{M_o}{M_p} = 1$$

WHERE:

Plastic Design
(Continued)

$$\frac{P}{P_y} > .15$$

$$\frac{M_o}{M_p} \leq 1.18 \left(1 - \frac{P}{P_y} \right) \leq 1.0 \quad \text{Formula (21)}$$

Case II. For pin-based columns required to develop a hinge at one end only, and double curvature columns required to develop a hinge at one end when the moment at the other end would be less than the hinge value

$$\frac{M_o}{M_p} \leq B - C \left(\frac{P}{P_y} \right) \leq 1.0 \quad \text{Formula (22)}$$

WHERE:

$$B = 1.33 + \frac{\frac{l}{r}}{3080} + \frac{\left(\frac{l}{r} \right)^2}{185,000}$$

$$C = 1.11 + \frac{\frac{l}{r}}{190} - \frac{\left(\frac{l}{r} \right)^2}{9000} + \frac{\left(\frac{l}{r} \right)^3}{720,000}$$

$$\frac{l}{r} < 60 \text{ in plane of bending}$$

$$\frac{M_o}{M_p} = 1 \text{ where } \frac{P}{P_y} \leq .15$$

Case III. For columns bent in single curvature

(Formula (23))

$$\frac{M_o}{M_p} \leq 1.0 - H \left(\frac{P}{P_y} \right) - J \left(\frac{P}{P_y} \right)^2$$

WHERE:

$$H = .420 + \frac{\frac{l}{r}}{70} - \frac{\left(\frac{l}{r} \right)^2}{29,000} + \frac{\left(\frac{l}{r} \right)^3}{1,160,000}$$

$$J = .770 - \frac{\frac{l}{r}}{60} + \frac{\left(\frac{l}{r} \right)^2}{8700} - \frac{\left(\frac{l}{r} \right)^3}{606,000}$$

**Plastic Design
(Continued)**

In no case shall the ratio of axial load to plastic load exceed the value determined by the following formula:

$$\frac{P}{P_y} = \frac{8700}{(l/r)^2} \text{ when } \frac{l}{r} > 120 \quad \text{Formula (24)}$$

(d) **Shear.** Unreinforced webs of columns, beams, and girders shall be so proportioned that

$$V_u \leq 0.00055 F_y w d$$

EXCEPTION: Webs subjected to shear forces may be considered adequate when

$$w > \frac{23,000 M}{A_{bc} F_y}$$

WHERE:

M = the algebraic sum of clockwise and counter-clockwise moment (in kip-feet) applied on opposite sides of the connection web boundary.

(e) **Web Crippling.** Web stiffeners are required on a member at a point of load application where a plastic hinge would form.

Web stiffeners are required at points where concentrated compression loads are delivered by the flanges to the web when

$$w < \frac{A_f}{t_b + 5k}$$

and at points where concentrated tension loads are delivered by the flange to the web when

$$t_f < 0.4 \sqrt{A_f}$$

WHERE:

w = thickness of web to be stiffened.

k = distance from outer face of flange to web toe of fillet of member to be stiffened.

t_f = thickness of flange of member to be stiffened.

t_b = thickness of flange delivering concentrated load.

A_f = area of flange delivering concentrated load.

The area of such stiffeners, " A_{st} ," shall be such that

$$A_{st} \geq A_f - w (t_b + 5k)$$

Their ends shall be fully welded to the inside face of the flange opposite the concentrated tensile load. They may be fitted against the inside face of the flange opposite the concentrated compression load. When the concentrated load delivered by a beam occurs on one side only, the web stiffener need not exceed one-half the depth of the member, but the welding connecting it to the web shall be sufficient to develop " $F_y A_{st}$."

**Plastic Design
(Continued)**

(f) **Minimum Thickness.** Projecting compression elements involving plastic hinge rotation under ultimate loading shall have width-thickness ratios no greater than eight and one-half for built-up shapes and eight and three-fourths for rolled shapes. Portions of compression elements located between rows of stiffeners on connectors shall have width-thickness ratios no greater than 32.

The depth-thickness ratio of beam and girder webs subjected to plastic bending without axial loading shall not exceed 70. Members when subjected to combined axial force and plastic bending moment at ultimate loading shall have web depth thickness ratios not to exceed the value given by the formula

$$\frac{d}{w} \leq 70 - 100 \frac{P}{P_y} \quad \text{Formula (25)}$$

with a minimum value of 43.

(g) **Connections.** All connections shall be capable of resisting the moments, shears and axial loads to which they would be subjected by the ultimate loading.

Haunch-type connections, tapered or curved for architectural reasons, shall be so proportioned that the full plastic bending strength of the section adjacent to the connection can be developed.

Stiffeners shall be used to preserve the flange continuity of interrupted members at their junction with other members in a continuous frame. Such stiffeners shall be placed in pairs on opposite sides of the web of the member which extends continuously through the joint.

Rivets, welds and bolts shall be proportioned to resist the forces produced at ultimate load using allowable unit stresses equal to 1.67 times those permitted in other Sections of this Chapter.

High strength bolts may be proportioned, on the basis of their minimum guaranteed proof load, to resist the tension produced by the ultimate loading. When used to transmit shear produced by the ultimate loading, one bolt may be substituted for a rivet of the same nominal diameter. High strength bolts may be used in joints having painted contact surfaces when these joints are of such size that the slip required to produce bearing would not interfere with the formation, at ultimate loading, of the plastic hinges assumed in the design.

(h) **Lateral Bracing.** Members designed on the basis of ultimate load shall be adequately braced to resist lateral and torsional displacements at the plastic hinge locations. The laterally unsupported distance, " l_{cr} ," shall not exceed

$$l_{cr} = \left(60 - 40 \frac{M}{M_p} \right) r_y \quad \text{Formula (26)}$$

**Plastic Design
(Continued)**

except that it need not be less than " $35r_y$ "

WHERE:

r_y = the radius of gyration of the member about its weak axis.

M = the lesser of the moments at the ends of the unbraced segment.

M/M_p = the end moment ratio, is positive when the segment is bent in single curvature and negative when bent in double curvature.

EXCEPTION: Laterally unsupported lengths greater than specified above may be justified by an analysis based upon the amount of restraint present at the ends of the segment in the plane of the computed bending moments.

The foregoing provisions need not apply in the region of the last hinge to form, nor in members oriented with their weak axis normal to the plane of bending. However, in the region of the last hinge to form, and in regions not adjacent to a plastic hinge, the maximum distance between points of lateral support shall be such as to satisfy the requirements of Formulas (4), (5) and (6) in this Chapter. For this case the value of " f_o " and " f_b " shall be computed from the moment and axial force at ultimate loading, divided by the applicable load factor.

Members built into a masonry wall and having their web perpendicular to the wall can be assumed to be laterally supported with respect to their weak axis of bending.

(i) **Fabrication.** The provisions of U.B.C. Standard No. 27-2-64 with respect to workmanship shall govern the fabrication of structures, or portions of structures, designed on the basis of maximum strength, subject to the following limitations:

The use of sheared edges shall be avoided in locations subject to plastic hinge rotation at ultimate loading. If used they shall be finished smooth by grinding, chipping or planing.

In locations subject to plastic hinge rotation at ultimate loading, holes for rivets or bolts in the tension area shall be subpunched and reamed or drilled full size.

**Light
Steel
Construction**

Sec. 2722. (a) General. Steel studs, steel joists, and other supports used in the structural frame of light steel construction shall be lightweight rolled sections, or sections made of commonly accepted or specially formed light-gauge flat rolled sheets; or a combination of both used alone or in combination with other materials of construction. Such studs, supports, or steel joists may be of a determinate truss design with elements effectively joined together by arc or resistance welding, or by rivets. In the case of expanded sections, a portion of the metal may be left intact to form a connection. For steel studs the ratio of " l/r " shall not exceed 180.

**Light Steel
Construction
(Continued)**

U.B.C. Standard No. 27-10-64 shall be accepted as recognized engineering practice for the design of light steel structural members, except as otherwise specifically provided in this Code.

Open web or trussed members shall be so constructed that the lines of force of all connected members shall intersect at a point or proper allowance shall be made in the design for any resulting stress. The web elements shall be of sufficient strength to resist effectively the shearing stresses.

All connections shall be riveted, bolted, or welded. All steelwork, including welds and connections, except where entirely encased in concrete, shall be thoroughly cleaned and given one coat of acceptable metal protection well worked into the joints and open spaces.

Steel used to form individual structural members shall be not less than No. 18 U. S. Standard gauge in thickness.

EXCEPTION: Steel used to form load-carrying panels other than corrugated or ribbed roof or wall panels shall be not less than No. 22 U. S. Standard gauge in thickness. Corrugated or ribbed steel roof and wall panels shall be not less than No. 30 U. S. Standard gauge in thickness.

(b) **Stresses.** The unit design stress in structural members of light steel shall not exceed the minimum yield strength of the steel divided by 1.65. For steel conforming to Grade C (minimum yield point 33,000 pounds per square inch) of U.B.C. Standard No. 27-9-64 the maximum working stress shall not exceed 20,000 pounds per square inch. Steel of higher strength than Grade C shall be suitably identified as to yield point and ultimate strength.

(c) **Construction Details.** Steel studs or other steel supporting members used in the structural frame of light steel construction and steel joists shall be connected to the supporting beams, girders, foundations, or other steel supporting members by arc or resistance welding, riveting, bolting, or other approved methods. All such welds in light steel construction shall be made on two sides or two edges of each bearing in such a manner as to resist effectively the stresses developed. Resistance welding shall develop the full strength of the member welded.

Steel floor and roof members supported on masonry and reinforced concrete shall have end bearings at least four inches (4") in length and the ends of such members resting on masonry or reinforced concrete shall be provided with approved joist anchors thoroughly embedded therein.

Bearing plates, when required by design, shall be securely welded, bolted, or riveted to such floor and roof members, studs, or other supporting members.

Bearing studs or other vertical bearing members shall rest on a sole or plate having an effective width equal to the

**Light Steel
Construction
(Continued)**

depth of such member and having a sufficient cross section to transfer the required loads of the vertical member resting thereon unless such bearing vertical member is thoroughly embedded in the concrete foundation. Such soles or plates shall be effectively anchored to the foundation.

When bearing studs or other vertical bearing members are spliced, the full strength of such members shall be developed in the splice.

Where studs do not continue full length from one story through the next story above, a cap plate or steel member shall be provided on top of the lower story studs or a sill plate on the upper story. Such cap plate or sill plate shall be of sufficient strength to distribute adequately the loads from the upper story studs to the lower story studs.

All horizontal or diagonal ties or bracing in exterior walls and bearing partitions shall be effectively arc welded, bolted, or riveted to the structural frame or effectively anchored to supporting masonry.

Where plumbing, heating, or other pipes or conduits are placed in or partly in an exterior wall or bearing partition necessitating the cutting of soles or plates, bracing or structural member in said wall, such members shall be reinforced so as to provide sufficient strength to resist the stresses imposed thereon or proper provisions shall be made to transfer such stresses to the points of support.

PART VII

DETAILED REGULATIONS

CHAPTER 28—EXCAVATIONS, FOUNDATIONS, AND RETAINING WALLS

Sec. 2801. The quality and design of materials used structurally in excavations, footings and foundations shall conform to the requirements specified in Chapters 23, 24, 25, 26, and 27 of this Code.

**Quality and
Design**

Sec. 2802. (a) General. Excavations or fill for buildings and excavations or fill accessory thereto shall be protected and guarded against danger to life and property. Permanent excavations or fill shall have retaining walls sufficient in strength to retain the embankment together with any surcharged loads. No excavation for any purpose shall extend within one foot (1') of the angle of repose or natural slope of the soil under any footing or foundation, unless such footing or foundation is first properly underpinned or protected against settlement.

Excavations

(b) Protection of Adjoining Property. Any person making or causing an excavation to be made to a depth of twelve feet (12') 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 twelve feet (12') 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 10 days before such excavation is to be made that the excavation is to be made and that the adjoining buildings should be protected. The owners of the adjoining properties shall be given access to the excavation for the purpose of protecting such adjoining buildings.

Any person making or causing an excavation to be made exceeding twelve feet (12') in depth below the grade, shall protect the excavation so that the adjoining soil will not cave in or settle, and shall extend the foundation of any adjoining buildings below the depth of twelve feet (12') below grade at his own expense. The owner of the adjoining buildings shall extend the foundations of his buildings to a depth of twelve feet (12') below grade at his own expense as provided in the preceding paragraph.

Sec. 2803. (a) General. The classification of the soil under all portions of every building shall be based upon the examination of adequate test borings or excavations made at the

**Soil
Classification**

Soil
Classification
(Continued)TABLE NO. 28-A—FOUNDATIONS FOR STUD BEARING WALLS
MINIMUM REQUIREMENTS

NUMBER OF STORIES	THICKNESS OF FOUNDATION WALL (Inches)		WIDTH OF FOOTING (Inches)	THICKNESS OF FOOTING (Inches)	DEPTH OF FOUNDATION BELOW NATURAL SURFACE OF GROUND AND FINISH GRADE (Inches)
	CONCRETE	UNIT MASONRY			
1	6	6	12	6	12
2	8	8	15	7	18
3	10	10	18	8	24

NOTES:

Where unusual conditions or frost conditions are found, footings and foundations shall be as required in Section 2806 (a).

The ground under the floor may be excavated to the elevation of the top of the footing.

site when required by the Building Official. The location of the test borings or excavations and the nature of the subsurface materials shall be indicated on the plans.

EXCEPTION: Certain buildings of Type V construction may have footings and foundations designed in accordance with the provisions of Section 2806 and Table No. 28-A.

(b) **Moisture Content.** Due allowance shall be made in determining the capacity of subsurface materials for the effect of possible change in moisture content.

(c) **Unequal Loads.** Where footings are to be placed at varying elevations the effect of adjacent loads shall be included in the foundation analysis.

Allowable
Soil
Pressures

Sec. 2804. The allowable unit soil pressure upon every footing shall not exceed the values as set forth in Tables No. 28-B and No. 28-C.

EXCEPTION: The tabulated values may be modified as prescribed in Section 2805.

Soil
Requirements

Sec. 2805. (a) Requirements. Whenever, in the opinion of the Building Official, the adequacy and class of a soil cannot be determined by the test borings or excavations required by the provisions of Section 2803 (a), he may require a special soil investigation before approving the use of the footing.

(b) **Deviations.** Deviations from the allowable unit soil pressures set forth in Tables No. 28-B and No. 28-C shall be permitted only after performance of a special soil investigation by an agency acceptable to the Building Official. The Building Official may approve such deviations only after receiving a written opinion from the investigating agency together with substantiating evidence.

TABLE NO. 28-B—ALLOWABLE SOIL PRESSURE

CLASS OF MATERIAL	MINIMUM DEPTH OF FOOTING BELOW ADJACENT VIRGIN GROUND	VALUE PERMISSIBLE IF FOOTING IS AT MINIMUM DEPTH, POUNDS PER SQUARE FOOT	INCREASE IN VALUE FOR EACH FOOT OF DEPTH THAT FOOTING IS BELOW MINIMUM DEPTH, POUNDS PER SQUARE FOOT	MAXIMUM VALUE POUNDS PER SQUARE FOOT
1	2	3	4	5
Rock	0'	20% of ultimate crushing strength	0	20% of ultimate crushing strength
Compact coarse sand	1'	1500 ¹	300 ¹	8000
Compact fine sand	1'	1000 ¹	200 ¹	8000
Loose sand	2'	500 ¹	100 ¹	3000
Hard clay or sandy clay	1'	4000	800	8000
Medium-stiff clay or sandy clay	1'	2000	200	6000
Soft sandy clay or clay	2'	1000	50	2000
Adobe	1'6"	1000 ²	50	
Compact inorganic sand and silt mixtures	1'	1000	200	4000
Loose inorganic sand silt mixtures	2'	500	100	1000
Loose organic sand and silt mixtures and muck or bay mud	0'	0	0	0

¹These values are for footings one foot (1') in width and may be increased in direct proportion to the width of the footing to a maximum of three times the designated value.

²For depths greater than eight feet (8') use values given for clay of comparable consistency.

**Soil
Requirements
(Continued)**

(c) **Load Tests.** Where the bearing capacity of the soil is not definitely known or is in question, the Building Official may require load tests or other adequate proof as to the permissible safe bearing capacity at that particular location. To determine the safe bearing capacity of soil it may be tested by loading an area not less than two square feet (2 sq. ft.) to not less than twice the maximum bearing capacity desired for use. Such load shall be sustained by the soil until no additional settlement takes place for a period of not less than 48 hours in order that such desired bearing capacity may be used. Examination of subsoil conditions may be required when deemed necessary.

Footings

Sec. 2806. (a) General. Footings and foundations, unless otherwise specifically provided, shall be constructed of masonry or concrete and shall in all cases extend below the frost line. Foundation walls supporting wood shall extend at least six inches (6") above the finish grade adjacent to the wall at all points. Mortar used in foundation walls and footings shall be as specified in Section 2403 (t).

(b) **Bearing Walls.** Bearing walls shall be supported on continuous solid masonry or concrete footings or piles, which shall be of sufficient size to support safely the loads imposed as determined from the character of the soil. Minimum foundation requirements for stud bearing walls shall be as set forth in Table No. 28-A.

EXCEPTIONS: 1. Interior bearing walls in one-story buildings may be supported on piers.

2. Exterior bearing walls in one-story Type V buildings (except Groups H and I Occupancies) may be supported on piers.

3. A one-story wood frame building which is not used for human occupancy and which does not exceed four hundred square feet (400 sq. ft.) in area, including additions, may be constructed without a masonry or concrete foundation if the walls are supported on a wood foundation plate.

4. The support of buildings by posts embedded in earth shall be designed as specified in Section 2806 (f). Wood posts or poles embedded in earth shall be pressure treated with an approved preservative. Steel posts or poles shall be protected as specified in Section 2808 (f).

(c) **Stepped Foundations.** Foundations for all buildings where the surface of the ground slopes more than one foot (1') in ten feet (10') shall be level or shall be stepped so that both top and bottom of such foundation are level.

(d) **Footing Design.** Except for special provisions of Section 2808 covering the design of piles, all portions of footings shall be designed in accordance with the structural provisions

of this Code and shall be designed to minimize differential settlement.

**Footings
(Continued)**

(e) **Foundation Plates or Sills.** Foundation plates or sills shall be bolted to the foundation or foundation wall with not less than one-half-inch ($\frac{1}{2}$ ") bolts embedded at least seven inches (7") into the masonry or concrete and spaced not more than six feet (6') apart. Foundation plates and sills shall be the kind of wood specified in Section 2517 (c).

(f) **Designs Employing Lateral Bearing.** Construction employing posts or poles as columns embedded in earth or embedded in concrete footings in the earth may be used to resist both axial and lateral loads. The depth to resist lateral loads shall be determined by means of the design criteria established herein or other methods approved by the Building Official.

1. **Design criteria—nonconstrained.** The following formula may be used in determining the depth of embedment required to resist lateral loads where no constraint is provided at the ground surface, such as rigid floor or ground surface pavement.

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

WHERE:

$$A = \frac{2.34P}{S_1 b}$$

P = Applied lateral force in pounds.

S_1 = Allowable lateral soil-bearing pressure as set forth in Table No. 28-C based on a depth of one-third the depth of embedment.

S_3 = Allowable lateral soil-bearing pressure as set forth in Table No. 28-C based on a depth equal to the depth of embedment.

b = Diameter of round post or footing or diagonal dimension of square post or footing (feet).

h = Distance in feet from ground surface to point of application of "P."

d = Depth of embedment in earth in feet but not over twelve feet (12') for purpose of computing lateral pressure.

Constrained. The following formula may be used to determine the depth of embedment required to resist lateral loads where constraint is provided at the ground surface, such as a rigid floor or pavement.

$$d^2 = 4.25 \frac{Ph}{S_3 b}$$

Footings
(Continued)

TABLE NO. 28-C—ALLOWABLE LATERAL SOIL PRESSURE

CLASS OF MATERIAL	ALLOWABLE VALUES PER FOOT OF DEPTH BELOW NATURAL GRADE ¹ (Pounds per Square Foot)	MAXIMUM ALLOWABLE VALUES (Pounds per Square Foot)
Good—compact well-graded sand and gravel Hard Clay Well-graded fine and coarse sand (All drained so water will not stand)	400	8000
Average—Compact Fine Sand Medium Clay Compact sandy loam Loose Coarse sand and gravel (All drained so water will not stand)	200	2500
Poor—Soft Clay Clay Loam Poorly compacted sand Clays containing large amounts of silt (Water stands during wet sea- son)	100	1500

¹Isolated poles, such as flagpoles, or signs, may be designed using lateral bearing values equal to two times tabulated values.

Vertical load. The resistance to vertical loads is determined by the allowable soil-bearing pressure set forth in Table No. 28-B.

2. **Construction requirements—backfill.** The backfill in the annular space around columns not embedded in poured footings shall be by one of the following methods:

- Backfill shall be of concrete with an ultimate strength of 2000 pounds per square inch at 28 days. The hole shall be not less than four inches (4") larger than the diameter of the column at its bottom or four inches (4") larger than the diagonal dimension of a square or rectangular column.
- Backfill shall be of clear sand. The sand shall be thoroughly compacted by tamping in layers not more than eight inches (8") in depth.

3. **Limitations.** The design procedure outlined in this Subsection shall be subject to the following limitations:

The frictional resistance for retaining walls and slabs on silts and clays shall be limited to one-half of the normal force imposed on the soil by the weight of the footing or slab.

Posts embedded in earth shall not be used to provide lateral support for structural or nonstructural materials such as plas-

ter, masonry or concrete unless bracing is provided that develops the limited deflection required.

Sec. 2807. When grillage footings of structural steel shapes are used on soils, they shall be completely embedded in concrete with at least six inches (6") on the bottom and at least four inches (4") at all other points.

**Grillage
Footings**

Sec. 2808. (a) General. The use of types of piles not specifically mentioned in this Chapter, and the use of piles under conditions not specifically covered herein, shall be permitted, subject to the approval of the Building Official, upon submission of acceptable test data, calculations, or other information relating to the properties and load-carrying capacity of such piles.

Piles

(b) **Column Action.** All piles standing unbraced in air, water, or material not capable of lateral support, shall conform with the applicable column formula as specified in this Code. Such piles driven into firm ground may be considered fixed and laterally supported at five feet (5') below the ground surface and in soft material at ten feet (10') below the ground surface unless otherwise prescribed by the Building Official after a foundation investigation by an approved agency.

(c) **Group Action.** Consideration shall be given to the reduction of allowable pile load when piles are placed in groups. Where soil conditions make such load reductions advisable or necessary, the allowable axial load determined for a single pile shall be reduced by any rational method or formula approved by the Building Official.

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

Where the influence of subsiding fills is considered as imposing loads on the pile, the allowable stresses specified in this Chapter may be increased if satisfactory substantiating data are submitted.

(e) **Jetting.** Jetting shall not be used except where and as specifically permitted by the Building Official. When used, jetting shall be carried out in such a manner that the carrying capacity of existing piles and structures shall not be impaired. After withdrawal of the jet, piles shall be driven down until the required resistance is obtained.

(f) **Protection of Pile Materials.** Where the boring records of site conditions indicate possible deleterious action on pile materials because of soil constituents, changing water levels, or other factors, such materials shall be adequately protected by methods or processes approved by the Building Official. The effectiveness of such methods or processes for the particu-

Piles
(Continued)

lar purpose shall have been thoroughly established by satisfactory service records or other evidence which demonstrates the effectiveness of such protective measures.

(g) **Allowable Loads.** The allowable loads based upon soil conditions shall be established in accordance with Section 2809.

EXCEPTION: Any uncased cast-in-place pile may be assumed to develop a frictional resistance equal to one-sixth of the bearing value of the soil material at minimum depth as set forth in Table No. 28-B but not to exceed 500 pounds per square foot unless a greater value is prescribed by the Building Official after a soil investigation as specified in Section 2805. Frictional resistance and bearing resistance shall not be assumed to act simultaneously.

(h) **Allowable Pile Stresses.** The allowable compressive stresses on all piling materials shall not exceed the values set forth in Section 2810, except that stresses may be increased on submission of satisfactory data for specially protected, selected, or high-strength material. In determining stresses the full load shall be assumed as carried on the pile cross section located at the upper surface of the soil supporting the pile.

**Allowable Pile
Loads Based on
Soil Conditions**

Sec. 2809. (a) General. The allowable axial and lateral loads on piles shall be determined by an approved formula, by load tests, or by a foundation investigation by an approved agency. A foundation investigation shall be made if required by the Building Official.

(b) **Allowable Loads. 1. Dynamic load tests.** The allowable axial load on a pile shall not exceed the value given by the following formulas unless such load is otherwise determined as specified in Section 2805.

Allowable Axial Load = $R/4$ for all piles.

WHERE:

$$R \text{ (for steel piles)} = \frac{12 Wh \frac{W + 0.25P}{W + P}}{S + \frac{RL 24,000}{AE}}$$

$$R \text{ (for other piles)} = \frac{12 Wh \frac{W + 0.1P}{W + P}}{S + \frac{RL 24,000}{AE}}$$

WHERE:

- R = ultimate driving resistance, in tons.
 W = weight of striking parts, in tons.
 h = height of fall of striking parts, in feet.
 Wh = striking energy, in foot tons.
 P = weight of pile, in tons.
 S = permanent settlement of pile under the average of the last 10 blows, in inches.
 L = length of pile, in feet.
 A = average right cross-sectional area of pile material, in square inches.
 E = modulus of elasticity of pile, in pounds per square inch.

Allowable Pile
 Loads Based on
 Soil Conditions
 (Continued)

2. **Static load tests.** When the allowable axial load of a single pile is determined by load test, one of the following methods shall be used:

Method 1. It shall not exceed 50 per cent of the yield point under test load. The yield point shall be defined as that point at which an increase in load produces a disproportionate increase in settlement.

Method 2. It shall not exceed one-half of the load which causes a net settlement, after deducting rebound, of one one-hundredth inch (.01") per ton of test load, which has been applied for a period of at least 24 hours.

Method 3. It shall not exceed one-half of that load under which, during a 40-hour period of continuous load application, no additional settlement takes place.

Sec. 2810. (a) Round Wood Piles. 1. Material. Except where untreated piles are permitted, wood piles shall be pressure-treated in accordance with U.B.C. Standard No. 25-12-64. The basic material shall conform to that of untreated piles. Untreated piles may be used only when it has been established that the cutoff will be below lowest ground-water level assumed to exist during the life of the structure. Every wood pile shall conform to the specification for Class A or Class B piles in U.B.C. Standard No. 25-14-64.

Specific
 Pile
 Requirements

2. **Allowable stresses.** The allowable stress in compression parallel to the grain of round wood piles shall not exceed 60 per cent of the basic stress for clear material as set forth in U.B.C. Standard No. 25-1-64 and in no event shall the stress exceed 1000 pounds per square inch.

(b) **Uncased Cast-in-Place Concrete Piles. 1. Material.** Concrete piles cast in place against earth in drilled or bored holes shall be made in such a manner as to insure the exclusion of any foreign matter and to secure a full-sized shaft. The length of such pile shall be limited to not more than 30 times the average diameter. Concrete shall have an ultimate com-

**Specific
Pile
Requirements
(Continued)**

pressive strength " f_c " of not less than 2500 pounds per square inch.

2. **Allowable stresses.** The allowable compressive stress in the concrete shall not exceed .225 f_c . The allowable stress in the reinforcing steel shall not exceed the values set forth in Chapter 26.

(c) **Metal-cased Concrete Piles.** 1. **Material.** All concrete used in metal-cased concrete piles shall have an ultimate compressive strength " f_c " of not less than 2500 pounds per square inch.

2. **Installation.** Every metal casing for a concrete pile shall have a sealed tip with a diameter of not less than eight inches (8").

Concrete piles cast in place in metal shells shall have shells driven for their full length in contact with the surrounding soil and left permanently in place. The shells shall be sufficiently strong to resist collapse and sufficiently watertight to exclude water and foreign material during the placing of the concrete.

Piles shall be driven in such order and with such spacing as to insure against distortion of or injury to piles already in place. No pile shall be driven within four and one-half average pile diameters of a pile filled with concrete less than 24 hours old unless approved by the Building Official.

3. **Allowable stresses.** The allowable stresses shall not exceed the values set forth in Section 2810 (b) 2.

(d) **Precast Concrete Piles.** 1. **Material.** Precast concrete piles shall be cast in one piece and prior to driving and at 28 days after pouring shall develop an ultimate compressive strength " f_c " of at least 3000 pounds per square inch.

2. **Reinforcement ties.** The longitudinal reinforcement in driven precast concrete piles shall be laterally tied with steel ties or wire spirals. Ties and spirals shall be spaced not more than three inches (3") apart, center-to-center, for a distance of two feet (2') from the ends and not more than eight inches (8") elsewhere. The gauge of ties and spirals shall be as follows:

For piles having a diameter of sixteen inches (16") or less, wire shall be not smaller than No. 5 gauge.

For piles having a diameter of more than sixteen inches (16") and less than twenty inches (20") wire shall be not smaller than No. 4 gauge.

For piles having a diameter twenty inches (20") and larger, wire shall be not smaller than one-fourth inch ($\frac{1}{4}$ ") round or No. 3 gauge.

3. **Allowable stresses.** Precast concrete piling shall be designed to resist stresses induced by handling and driving

as well as by loads. The allowable stresses shall not exceed the values set forth in Section 2810 (b) 2.

**Specific
Pile
Requirements
(Continued)**

(e) **Precast Prestressed Concrete Piles (Pretensioned).** 1. **Material.** Rolled and fabricated structural steel piles shall conform to U.B.C. Standard No. 27-1-64.

2. **Reinforcement.** The longitudinal reinforcement shall be high tensile seven wire strand conforming to U.B.C. Standard No. 26-7-64. Longitudinal reinforcement shall be laterally tied with steel ties or wire spirals.

Ties or spiral reinforcement shall be spaced not more than three inches (3") apart center-to-center for a distance of two feet (2') from the ends, and not more than eight inches (8") elsewhere.

At each end of the pile the first five ties or spirals shall be spaced one inch (1") center-to-center.

For piles having a diameter of twenty-four inches (24") or less, wire shall be not smaller than No. 5 gauge. For piles having a diameter greater than twenty-four inches (24"), but less than thirty-six inches (36"), wire shall not be smaller than No. 4 gauge. For piles having a diameter greater than thirty-six inches (36"), wire shall be not smaller than one-fourth-inch ($\frac{1}{4}$ ") round or No. 3 gauge.

3. **Allowable stresses.** Precast prestressed piling shall be designed to resist stresses induced by handling and driving as well as by loads. The effective prestress in the pile shall not be less than 400 pounds per square inch for piles up to thirty feet (30') in length, 550 pounds per square inch for piles up to fifty feet (50') in length, and 700 pounds per square inch for piles greater than fifty feet (50') in length.

The allowable compressive stress in the concrete due to externally applied load shall not exceed $0.20 "f_c"$.

If the compressive stress due to effects of prestressing exceeds $0.20 "f_c"$, the allowable compressive stress due to externally applied loads as permitted above, shall be reduced accordingly.

Effective prestress shall be based on an assumed loss of 30,000 pounds per square inch in the prestressing steel.

The allowable stress in the prestressing steel shall not exceed the values set forth in U.B.C. Standard No. 26-13-64.

(f) **Rollled Structural Steel Piles.** 1. **Material.** Structural steel piles shall conform to U.B.C. Standard No. 27-1-64.

No section shall have a nominal thickness of metal less than three-eighths inch ($\frac{3}{8}$ ").

2. **Allowable stresses.** The allowable stresses shall not exceed 12,000 pounds per square inch.

(g) **Concrete-filled Steel Pipe Piles.** 1. **Material.** Steel pipe piles shall conform to U.B.C. Standard No. 27-1-64. If

**Specific Pile
Requirements
(Continued)**

it is desired to use pipe of other material, satisfactory substantiating data must be submitted.

The concrete used in concrete-filled steel pipe piles shall have an ultimate compressive strength " f'_c " of not less than 2500 pounds per square inch.

2. **Allowable stresses.** The allowable stresses shall not exceed 12,000 pounds per square inch on the steel plus .25 of the ultimate compressive strength " f'_c " of the concrete.

CHAPTER 29—VENEERED WALLS

Sec. 2901. (a) Limitations. Veneer shall not be assumed to add to the strength of any wall. **General**

(b) **Height.** Exterior veneer shall not be attached to wood at any point more than twenty feet (20') above the adjacent ground elevation.

(c) **Horizontal Forces.** Veneer shall not be assumed to resist horizontal forces, except as specifically provided in Section 2902.

(d) **Exceptions.** The limitations in this Chapter shall not apply to interior veneer of units five-eighths inch ($\frac{5}{8}$ ") or less in thickness.

Sec. 2902. (a) Scope. The provisions of this Section shall apply to all veneer which is constructed of masonry conforming to the requirements of Chapter 24. **Veneer of Masonry Units**

(b) **Vertical Loads.** No veneer shall support any vertical load other than the dead load of the veneer above. Veneer above openings shall be supported upon lintels of incombustible material.

(c) **Anchorage.** Masonry veneer shall be attached to the supporting wall with corrosion-resistant metal ties, or other approved method, designed to resist a horizontal force equal to twice the weight of the attached veneer.

Veneer ties, if strand wire, shall be not less in thickness than No. 6 U. S. gauge wire and shall have a hook embedded in the mortar joint, or if sheet metal, not less than No. 22 U. S. gauge corrugated. Each tie shall support not more than two square feet (2 sq. ft.) of wall area and shall be spaced not more than twenty-four inches (24") on center horizontally.

In lieu of such wire ties, an approved method of grouting the veneer to a paperbacked reinforcement attached direct to the studs may be used.

(d) **Support.** The weight of masonry veneer shall be supported upon footings or other incombustible structural supports spaced not over twelve feet (12') vertically above a point twenty feet (20') above the adjacent ground elevation.

EXCEPTION: The weight of masonry veneer attached to wood frame walls shall be supported entirely upon footings.

Sec. 2903. (a) Scope. The provisions of this Section shall apply to all veneer of materials not regulated by the requirements of Chapter 24. **Veneer of Nonstructural Units**

**Veneer of
Nonstructural
Units
(Continued)**

(b) **Loads and Stresses.** For the purpose of this Section, veneer of nonstructural units shall not be assumed to support any superimposed loads.

(c) **Anchorage.** Nonstructural material used as veneer shall be anchored to the supporting wall by corrosion-resistant metal ties not less in thickness than No. 9 U. S. gauge wire, and spaced not more than twelve inches (12") apart both horizontally and vertically.

EXCEPTION: Approved units, or units of flat tile, stone, or terra cotta which are manufactured with scored surface may be cemented to a masonry or concrete wall or to exterior plaster with Type A portland cement mortar, provided the mortar bond is sufficient to withstand a shearing stress of 50 pounds per square inch after curing for 28 days.

**Special
Requirements
for Glass
Veneer**

Sec. 2904. (a) General. In addition to the general requirements of this Chapter, all veneer of glass shall comply with the regulations in this Section.

Glass veneer shall not be attached to any exterior wall at a point more than thirty-five feet (35') above the adjoining ground elevation.

(b) **Dimension.** Glass-veneer units shall be not less than one-eighth inch ($\frac{1}{8}$ ") in thickness. Units less than three-sixteenths inch ($\frac{3}{16}$ ") in thickness shall be not larger in area than one square foot (1 sq. ft.). Units not more than one-fourth inch ($\frac{1}{4}$ ") nor less than three-sixteenths inch ($\frac{3}{16}$ ") in thickness shall be not larger in area than four square feet (4 sq. ft.).

No unit shall be larger in area than ten square feet (10 sq. ft.) or more than four feet (4') in length.

(c) **Attachment.** Every glass-veneer unit shall be attached to the backing by approved corrosion-resistant ties and shall be supported upon shelf angles.

EXCEPTIONS: 1. Below a point twenty-two feet (22') above the adjacent ground elevations, the ties may be omitted.

2. Below a point three feet (3') above the adjacent ground elevations, the ties and shelf angles may be omitted.

(d) **Mastic.** The mastic shall cover not less than one-half of the area of the unit after the unit has been set in place and shall be neither less than one-fourth inch ($\frac{1}{4}$ ") nor more than one-half inch ($\frac{1}{2}$ ") in thickness.

The mastic shall be insoluble in water and shall not lose its adhesive qualities when dry.

Absorbent surfaces shall be sealed by a bonding coat before mastic is applied. The bonding coat shall be cohesive with the mastic.

Glass-veneer surfaces to which mastic is applied shall be clean and uncoated.

(e) **Shelf Angles.** Shelf angles shall be of corrosion-resistant material capable of supporting four times the weight of the supported veneer.

The shelf angles shall be spaced vertically in alternate horizontal joints but not more than three feet (3') apart.

The shelf angles shall be spaced not farther apart horizontally than the width of the supported units.

(f) **Backing.** Exterior glass veneer shall be applied only upon masonry, concrete, or exterior plaster.

(g) **Expansion Joints.** Glass-veneer units shall be separated from each other and from adjoining materials by an expansion joint at least one thirty-second inch ($\frac{1}{32}$ ") in thickness. There shall be at least one sixty-fourth-inch ($\frac{1}{64}$ ") clearance between bolts and the adjacent glass.

**Special
Requirements
for Glass
Veneer
(Continued)**

CHAPTER 30—ENCLOSURE OF VERTICAL OPENINGS

**Enclosures:
When
Required**

Sec. 3001. Vertical openings are required to be enclosed as set forth in Table No. 17-A. For enclosures of stairways and ramps see Chapter 33.

**Elevator
Enclosures**

Sec. 3002. Walls and partitions enclosing elevators and escalators shall be of not less than the fire-resistive construction required under Types of Construction in Part V. Enclosing walls of elevator shafts may consist of wire glass set in metal frames on the entrance side only. Elevator shafts extending through more than two stories shall be equipped with an approved means of adequate ventilation to and through the main roof of the building.

EXCEPTION: In buildings housing Groups F and G Occupancies and where such buildings are equipped with automatic fire-extinguishing systems throughout, enclosures shall not be required for escalators, provided, however, that the top of the escalator opening at each story shall be provided with a draft curtain.

Such draft curtain shall enclose the perimeter of the unenclosed opening and shall extend from the ceiling downward at least twelve inches (12") on all sides. Automatic sprinklers shall be provided around the perimeter of the opening and within two feet (2') of the draft curtain. The distance between the sprinklers shall not exceed six feet (6') center-to-center.

**Other
Vertical
Openings**

Sec. 3003. All shafts, ducts, chutes, and other vertical openings not covered in Section 3002 shall have enclosing walls conforming to the requirements specified under Type of Construction of the building in which they are located.

Air Ducts

Sec. 3004. Air ducts passing through a floor shall be enclosed in a shaft. The shaft shall be as required for vertical openings in Part V. Dampers shall be installed where ducts pierce the shaft enclosure walls. Dampers shall conform to U.B.C. Standard No. 30-1-64. Air ducts in Group I Occupancies need not be enclosed in a shaft if conforming to Chapter 51. (See Appendix.)

CHAPTER 31—FLOOR CONSTRUCTION

Sec. 3101. Floor construction shall be of materials and construction as specified under Occupancy in Part III and under Types of Construction in Part V. **General**

All floors shall be so framed and tied into the framework and supporting walls as to form an integral part of the whole building.

The types of floor construction used shall provide means to keep the beams and girders from spreading by installing either ties or bridging, with no laterally unsupported length of joists being permitted to exceed eight feet (8') except as otherwise specified in Section 3102.

Fire-resistive standards of floor construction are specified in Section 4305.

Sec. 3102. Joists shall be securely cross bridged at intervals not to exceed eight feet (8') along the joist length. Bridging shall be provided during the period of construction to support adequately the top chord or flange against lateral movement and such bridging shall be designed to hold each joist in a vertical plane. Sufficient permanent bridging shall be installed to stay the joists laterally and to transmit any horizontal forces in either direction perpendicular to the direction of the joists. Such bridging shall consist of solid concrete sections, structural steel shapes or plates, portal bridging, diagonal rods, or other bridging which will provide equal stiffness. Any row of bridging shall be capable of transferring 500 pounds from each joist to the adjoining joists. **Steel-Joisted Floors**

Sec. 3103. Wood-joisted floors shall be framed and constructed and anchored to supporting wood stud or masonry walls as specified in Chapter 23. **Wood Floors**

In wood frame floor construction where suspended ceilings occur, the space between the ceiling and the floor above shall be divided into areas not exceeding one thousand square feet (1000 sq. ft.) in a manner required for partitioning attic space in Section 3205.

An access crawl hole eighteen inches by twenty-four inches (18" x 24") shall be provided to under floor space.

CHAPTER 32—ROOF CONSTRUCTION AND COVERING

General

Sec. 3201. Roof coverings for all buildings shall be either fire-retardant or ordinary as set forth in this Chapter and as required by Occupancy in Part III, by Location in Part IV or by Type of Construction in Part V. For general requirements see Section 1704.

The roof covering shall be securely fastened in an approved manner to the supporting roof construction.

The roof covering shall provide weather protection for the building at the roof.

Construction

Sec. 3202. The general requirements for construction of floors as specified in Chapter 31 shall apply to roofs, except that concrete or gypsum roof slabs shall be not less than two inches (2") in thickness.

All roofs shall be so framed and tied into the framework and supporting walls as to form an integral part of the whole building. Roof trusses shall have all joints well fitted and shall have all tension members well tightened before any load is placed on the truss. Diagonal and sway bracing shall be used to brace all roof trusses. The allowable working stresses of materials in trusses shall be as specified in Chapters 25 and 27. The minimum net section of the members after framing shall be used in determining the strength of the truss at any point.

Plywood roof sheathing, unless of exterior type, shall have no surface or edge exposed to the weather and shall be of minimum thicknesses set forth in Table No. 25-P.

Roof Coverings

Sec. 3203. (a) General. Roof coverings shall be as specified in this Section.

(b) Definitions. For purposes of this Chapter certain terms are designated as follows:

BASE SHEETS are one or more layers of felt over which is applied a cap sheet, organic, asbestos or other inorganic fiber shingles or mineral aggregate.

BUILT-UP ROOF is two or more layers of roofing consisting of base sheets, and cap sheet, mineral aggregate, ceramic or other similar surfacing material.

CAP SHEET is roofing made of organic, asbestos or other inorganic fibers, saturated, and coated on both sides with a bituminous compound, and surfaced with mineral granules, mica, talc, ilmenite, asbestos or other inorganic fibers, or similar materials, except on the unexposed portions of split cap sheets.

CEMENTING is solidly mopped application of hot asphalt, cold liquid asphalt compound, hot coal tar pitch, or other approved cementing material.

COMBINATION SHEET is ply sheet integrally attached to kraft paper.

**Roof Coverings
(Continued)**

COMPOSITION ROOFING is any asphaltic roofing.

CORROSION-RESISTANT is any nonferrous metal, or any metal having an unbroken surfacing of nonferrous metal, or steel with not less than 10 per cent chromium or with not less than twenty-hundredths per cent copper.

DRY SHEET is felt or other approved underlay applied directly to the roof deck by approved means other than cementing. Dry sheets are not part of built-up roofing assemblies.

FELT is roofing felt made of organic, asbestos or other inorganic fibers, saturated with bituminous compound.

METAL ROOFING is metal shingles or sheets for application on solid roof surfaces, and corrugated or otherwise shaped metal sheets or sections for application on solid roof surfaces or roof frameworks.

PLY SHEET is glass fiber felt sheet coated on both sides with asphalt, and weighing approximately eight pounds per roofing square.

PREPARED ROOFING is any composition roofing other than built-up roofing assemblies.

ROOFING SQUARE is one hundred square feet (100 sq. ft.) of roofing surface.

SPOT-CEMENTING is discontinuous application of hot asphalt, cold liquid asphalt compound, hot coal tar pitch or other approved cementing material.

UNDERLAY is one or more layers of felt applied as required for a base sheet, over which finish roofing is applied.

WEIGHT is the manufacturer's shipping weight in pounds per one hundred square feet (100 sq. ft.) of roof coverage.

WOOD SHINGLES are tapered pieces of Western Red Cedar or Redwood, sawed both sides, of random widths ranging from three inches (3") to fourteen inches (14") and sixteen inches (16"), eighteen inches (18") or twenty-four inches (24") in length.

WOOD SHAKES are tapered or nontapered pieces of Western Red Cedar or Redwood of random widths ranging from four inches (4") to fourteen inches (14"), and of the following three types:

1. Hand-split and resawn; tapered and having one sawed and one split face, eighteen inches (18"), twenty-four inches (24") or thirty-two inches (32") in length.
2. Taper-split; tapered and having both split faces, twenty-four inches (24") in length.
3. Straight-split; nontapered and with both split faces, either eighteen inches (18") or twenty-four inches (24") in length.

(c) **Roofing Materials.** 1. **Materials.** Materials shall conform to the following Standards:

Roof Coverings
(Continued)

MATERIALS AND DESIGN	U. B. C. DESIGNATION
Asphalt, Roofing.....	{ 32- 1-64 32- 2-64
Coal Tar, Roofing.....	{ 32- 1-64 32- 2-64
Cap Sheet.....	32- 1-64
Mineral Surfaced.....	32- 3-64
Smooth Surfaced.....	32- 1-64
Felt, Roofing.....	32- 1-64
Metal Roofing.....	32- 4-64
Mineral Roofing Aggregate.....	32- 5-64
Nails, Corrosion-resistant.....	32- 6-64
ROOFING, COMPOSITION	
Class A.....	{ 32- 7-64 32- 1-64
Class B.....	{ 32- 7-64 32- 1-64
Class C.....	{ 32- 7-64 32- 3-64
Shakes, hand-split.....	32- 8-64
SHINGLES	
Asbestos	32- 7-64
Asbestos-cement	32- 9-64
Asphalt	32- 3-64
Slate	32-10-64
Wood	32-11-64
TILE	
Concrete	32-12-64
Clay	32-12-64
WIRE	
32-13-64	

2. **Identification.** All material shall be delivered in the original packages bearing the manufacturer's label.

3. **Built-up roofing materials.** Each package of felts, cements, and base-, ply-, combination or cap sheets shall bear the label of an approved testing laboratory having a service for the inspection of material and finished products during manufacture for such built-up roofing material.

4. **Metal roofing.** Metal roofing exposed to the weather shall be corrosion-resistant.

Corrugated or ribbed steel shall be not less than No. 30 galvanized sheet gauge.

Flat steel sheets shall be not less than No. 30 galvanized sheet gauge.

Flat nonferrous sheets and shingles shall be not less than No. 28 B. & S. gauge.

Other ferrous sections or shapes shall be not less than No. 26 galvanized sheet gauge. Other nonferrous sections or shapes shall be not less than No. 25 B. & S. gauge.

Corrugated or otherwise shaped sheets or sections shall be designed to support the required live load between supporting members.

Ferrous sheets or sections shall comply with Section 2722 of this Code.

5. **Nails.** Nails for composition roofs shall be not smaller than No. 12 gauge, with heads not less than three-eighths inch ($\frac{3}{8}$ ") in diameter for shingle application and seven-sixteenths inch ($\frac{7}{16}$ ") in diameter for built-up roofs, and shall be long enough to penetrate into the sheathing three-fourths inch ($\frac{3}{4}$ "), or through the thickness of the sheathing, whichever is less. Smaller size head nails may be used provided metal discs are used with them. Exposed nails and shingle nails shall be corrosion-resistant.

Nails for wood shingles shall be not less than No. 14½ gauge corrosion-resistant and shall be long enough to penetrate into the sheathing three-fourths inch ($\frac{3}{4}$ "), or through the thickness of the sheathing, whichever is less.

Nails for wood shakes shall be the same as required for wood shingles.

Nails for asbestos-cement shingles shall be not less than No. 11 gauge corrosion-resistant and shall be long enough to penetrate into the sheathing three-fourths inch ($\frac{3}{4}$ ") or through the thickness of the sheathing, whichever is less.

Nails for slate shingles, and clay or concrete tile shall be not less than No. 14 gauge copper or No. 14 gauge corrosion-resistant as specified and shall be long enough to penetrate into the sheathing three-fourths inch ($\frac{3}{4}$ "), or through the thickness of the sheathing, whichever is less.

Staples or other similar fastening devices shall not be used unless approved by the Building Official.

6. **Prepared roofing.** Each package of prepared roofing shall bear the label of an approved testing laboratory having a service for the inspection of material and finished products during manufacture for Class A, B or C roofing.

7. **Shakes.** Each bundle of wood shakes for roofs shall be of Western Red Cedar or Redwood and shall bear the label of an approved inspection bureau or agency certifying compliance with U.B.C. Standard No. 32-8-64.

8. **Shingles.** Each bundle of wood shingles for roofs shall bear the label of an approved inspection bureau or agency certifying compliance with U.B.C. Standard No. 32-11-64.

Packages of composition shingles shall bear the label of an approved testing laboratory having a service for the inspection of material and finished products during manufacture for Class A, B or C roofing.

Roof Coverings (Continued)

**Roof Coverings
(Continued)**

Slate shingles shall bear the label of an approved inspection bureau or agency certifying compliance with U.B.C. Standard No. 32-10-64. Ribbed or otherwise faulty slate shingles shall not be used.

9. **Wire.** Attaching wire for slate shingle and clay or concrete tile shall be not smaller than No. 14 gauge complying with U.B.C. Standard No. 32-13-64.

(d) **Application. 1. Built-up roofs.** Built-up roofing shall be applied only to solid surface roofs.

Base sheets shall be cemented to a suitable deck using not less than 25 pounds of hot asphalt or not less than two gallons of cold bituminous compound in accordance with manufacturer's published specifications or 30 pounds of hot coal tar pitch per roofing square, or nailed to roof sheathing using not less than one nail to each one and one-third square feet (1 1/3 sq. ft.), or may be spot-cemented to a non-naillable deck using not less than 10 pounds of hot asphalt per roofing square.

Successive layers shall be cemented to the base sheets using no less cementing material than that specified for solidly cemented base sheets.

Mineral aggregate¹ surfaced roofs shall be surfaced with not less than 50 pounds of hot asphalt or other cementing material in which is embedded not less than 300 pounds of gravel or other approved surfacing materials or 250 pounds of crushed slag per roofing square. See Section 3203 (e) 2 for minimum amounts of mineral aggregate on fire-retardant roofs.

Cap sheets shall be cemented to the base sheets using no less cementing material than that specified for solidly cemented base sheets.

Hot asphalt shall be applied at a temperature of not less than 375°F. nor more than 400°F. and shall not be heated to a temperature above 425°F.

Coal tar pitch shall not be heated to a temperature above 375°F.

2. **Composition shingles.** Composition shingles shall be applied only to solidly sheathed roofs, except when applied over existing wood shingle roofs, as approved by the Building Official.

Composition shingles shall be fastened according to manufacturer's printed instructions but not less than four nails per each strip shingle not more than thirty-six inches (36") wide and two nails per each individual shingle less than twenty inches (20") wide.

Composition shingles shall not be installed on a roof having a pitch of less than four inches (4") to twelve inches (12"), unless approved by the Building Official.

Composition shingle roofs shall have an underlay of not less than 15-pound felt, applied as required for a base sheet. The

¹See U.B.C. Standard No. 32-5-64 for mineral roofing aggregate weighing less than 60 pounds per cubic foot.

**Roof Coverings
(Continued)**

underlay may be omitted over existing roofs, or where the roof pitch exceeds seven inches (7") to twelve inches (12"), or where shingles are laid not less than three thicknesses at any point.

Roof valley flashing shall be the same as required for wood shingles, or shall be of laced composition shingles, applied in an approved manner, with an underlay of not less than 30-pound felt extending ten inches (10") from the center line each way, or shall be of two layers of 90-pound mineral surfaced cap sheet cemented together with the bottom layer not less than twelve inches (12") wide laid face down, and the top layer not less than twenty-four inches (24") wide laid face up.

3. **Slate shingles.** Slate shingles shall be applied in an approved manner and securely fastened with corrosion-resistant nails or corrosion-resistant nails and wire.

Slate shingle roofs shall have an underlay of not less than two layers of 15-pound felt or one layer of 30-pound felt, applied as required for a base sheet.

Roof valley flashing shall be the same as required for wood shakes.

4. **Asbestos-cement shingles and sheets.** Asbestos-cement roofing shall be applied in an approved manner. Asbestos-cement roofing shall have an underlay of not less than 15-pound felt, applied as required for a base sheet. The underlay may be omitted where the asbestos-cement shingles or sheets are applied over an existing roof covering.

Asbestos-cement roofing shall not be installed on a roof having a pitch of less than three inches (3") to twelve inches (12") unless approved by the Building Official.

Corrugated asbestos-cement roofing not less than five-sixteenths inch ($\frac{5}{16}$ ") thick may be used wherever No. 24 galvanized sheet gauge corrugated steel is permitted.

Roof valley flashing shall be the same as required for wood shakes.

5. **Metal roofing.** Flat sheets or shingles shall be applied only to solidly sheathed roofs.

Metal roofing shall be applied in an approved manner.

Metal shingles shall not be installed on a roof having a pitch of less than three inches (3") to twelve inches (12") unless approved by the Building Official.

Metal shingles shall be applied over an underlay of not less than 30-pound felt, applied as required for a base sheet.

6. **Tile, clay and concrete.** All roof tile shall be securely fastened with corrosion-resistant nails or nails and wire, or other approved means.

Tile shall not be installed on a roof having a pitch of less than three inches (3") to twelve inches (12") unless approved by the Building Official.

**Roof Coverings
(Continued)**

Tile with projecting anchor lugs at the bottom of the tiles shall be held in position by means of one-inch by two-inch (1" x 2") wood stripping, treated to resist moisture deterioration, nailed to the roof sheathing over the underlay, or other approved means.

Tile roofs shall have an underlay of not less than two layers of 15-pound felt or one layer of 30-pound felt, applied as required for a base sheet.

Roof valley flashing shall be the same as required for wood shakes.

7. Wood shingles. Shingles may be applied to roofs with solid or spaced sheathing. The spaced sheathing shall be spaced not to exceed four inches (4") clear nor more than the width of the sheathing board. Spaced sheathing shall be not less than one inch by three inches (1" x 3") nominal dimensions.

Shingles shall be laid with a side lap of not less than one and one-half inches (1½") between joints in adjacent courses, and one-half inch (½") in alternate courses. Spacing between shingles shall be not less than one-fourth inch (¼") nor more than three-eighths inch (⅜"). Each wood shingle shall be fastened to the sheathing with two nails only.

Shingles shall not be installed on a roof having a pitch less than four inches (4") to twelve inches (12") unless they are installed over an underlay of not less than 15-pound felt, applied as required for a base sheet, and unless approved by the Building Official.

Roof valley flashing shall be provided of not less than No. 28 galvanized sheet gauge corrosion-resistant metal and shall extend at least eight inches (8") from the center line each way, and shall have a splash diverter rib not less than three-fourths inch (¾") high at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than four inches (4").

Weather exposures shall not exceed those set forth in Table No. 32-A. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof.

8. Wood shakes. Shakes may be applied to roofs with solid or spaced sheathing. The spaced sheathing shall be spaced not to exceed four inches (4") clear nor more than the width of the sheathing board. Spaced sheathing shall be not less than one-inch by four-inch (1" x 4") nominal size. In snow areas when the roof pitch is less than eight inches (8") to twelve inches (12"), sheathing shall be solid and the shakes shall be applied over an underlay of not less than 15-pound felt, applied as required for a base sheet.

Shakes may be laid in straight or staggered courses. Shakes shall be laid with a side lap of not less than one and one-half inches (1½") between joints in adjacent courses. Edges shall be parallel within one inch (1"). Spacing between shakes shall be not more than one-half inch (½").

**Roof Coverings
(Continued)**

Each wood shake shall be fastened to the sheathing with two nails only. The starter course at the eaves shall be doubled and the bottom or first layer may be either fifteen-inch (15") or eighteen-inch (18") wood shakes or wood shingles. Fifteen-inch (15") or eighteen-inch (18") shakes may be used for the final course at the ridge.

Shakes shall be laid with not less than eighteen-inch (18") wide strips of not less than 30-pound felt shingled between each course in such a manner that no felt is exposed to the weather below the shake butts.

Shakes shall not be installed on a roof having a pitch less than four inches (4") to twelve inches (12") unless they are installed over an underlay of not less than 30-pound felt, applied as required for a base sheet, and unless approved by the Building Official.

Roof valley flashing shall be provided of not less than No. 28 galvanized sheet gauge corrosion-resistant metal and shall extend at least eleven inches (11") from the center line each way and shall have a splash diverter rib not less than one inch (1") high at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than four inches (4").

Weather exposures shall not exceed those set forth in Table No. 32-A. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof.

(e) **Fire-retardant Roof Coverings.** A fire-retardant roof covering shall be any one of the following roofings:

1. Any Class A or B built-up roofing assembly.
2. Any mineral aggregate surfaced built-up roof for application to roofs having a pitch not more than three inches (3") to twelve inches (12") applied as specified in

**TABLE NO. 32-A—MAXIMUM EXPOSURE TO WEATHER
WOOD SHINGLES**

PITCH OF ROOF		SHINGLE LENGTH		
Rise	Run	16-Inch	18-Inch	24-Inch
3" to less than 4"	12"	3¾"	4¼"	5¾"
4" to less than 5"	12"	4½"	5¼"	7"
5" or more	12"	5"	5½"	7½"
TAPERED WOOD SHAKES				
EXPOSURE TO WEATHER		LENGTH OF SHAKE		
7½"		18"		
10"		24"		
13"		32"		
STRAIGHT-SPLIT WOOD SHAKES				
5½"		18"		
7½"		24"		

Roof Coverings (Continued)

Section 3203 (d) 1 consisting of not less than the following:

Base Sheets

Four layers of 15-pound perforated organic fiber felt, or

Three layers of 15-pound organic or inorganic fiber felt, and

Surfacing Material¹

400 pounds per roofing square of gravel, crushed rock, ceramic or approved similar surfacing material, or

300 pounds per roofing square of crushed slag.

3. Any built-up roof for application to roofs having a pitch not less than one inch (1") to twelve inches (12"), applied as specified in Section 3203 (d) 1, consisting of not less than the following:

Base Sheets

Two layers of 15-pound organic fiber felt, or

One layer of 14-pound glass fiber felt base sheet, or combination sheet,² or

One layer of 30-pound organic fiber felt, or

One layer of 45-pound asbestos fiber felt base sheet, and

Cap Sheets

One layer of 90-pound mineral surfaced organic fiber felt cap sheet,³ or

Two layers of 55-pound mineral surfaced organic fiber felt split sheet, or

One layer of 80-pound mineral surfaced asbestos fiber felt cap sheet, or

One layer of 72-pound mineral surfaced glass fiber felt cap sheet,² or

Two layers of 15-pound asbestos fiber finishing felts.

4. Any Class A or B prepared roofing.
5. Any Class C mineral surfaced asphalt shingles laid so that there are not less than two thicknesses at any point and the total weight per roofing square is not less than 235 pounds.
6. Asbestos-cement shingles or sheets.
7. Concrete slab roof.
8. Metal roof covering.
9. Slate shingles.
10. Clay or concrete roof tile.

(f) **Ordinary Roof Covering.** An ordinary roof covering shall be any one of the following roofings:

1. Any roof covering listed in Section 3203 (e).

¹See U.B.C. Standard No. 32-5-64 for mineral roofing aggregate weighing less than 60 pounds per cubic foot.

²Glass fiber base and cap sheets shall not be used with base and cap sheets of other materials.

³Shall have a minimum underlay of two layers of organic fiber felt applied as required for base sheets.

2. Any built-up roofing assembly not less than Class C roofing.
3. Any mineral aggregate surfaced built-up roof for application to roofs having a pitch of not more than three inches (3") to twelve inches (12"), applied as specified in Section 3203 (d) 1, consisting of not less than the following:

Base Sheets

Three layers of 15-pound organic or inorganic fiber felt, and

Surfacing Material

300 pounds per roofing square of gravel or other approved surfacing material, or 250 pounds per roofing square of crushed slag.

4. Any prepared roofing not less than Class C roofing.
5. Wood shingles.
6. Wood shakes.

EXCEPTION: Unless otherwise required because of location as specified in Parts IV and V of this Code, Group J, Division 1, roof coverings shall consist of not less than one layer of 55-pound smooth surfaced organic cap sheet, or built-up roofing consisting of two layers of 15-pound organic fiber felt and one layer of surfacing material from Section 3203 (f) 3.

Sec. 3204. The use of combustible roof insulation shall be permitted in all Types of Construction provided it is covered with approved roof covering applied directly thereto.

Roof Insulation

Sec. 3205. (a) Access. An attic access opening shall be provided in the ceiling of the top floor of buildings with combustible ceiling or roof construction. The opening shall be located in a corridor or hallway of buildings of three or more stories in height, and readily accessible in buildings of any height.

Attics: Access, Area Separations and Ventilation

The opening shall be not less than twenty-two inches by thirty inches (22" x 30").

Thirty-inch (30") minimum clear head room shall be provided above the access opening.

Attics with a maximum vertical clear height of less than thirty inches (30") need not be provided with access openings.

For ladder requirements, see Section 5103 (c) 2.

(b) Area Separations. Enclosed attic spaces formed of combustible construction shall be divided into horizontal areas not exceeding two thousand and five hundred square feet (2500 sq. ft.) by partitions extending from the ceiling to the roof.

Such partitions shall be not less than one-half-inch ($\frac{1}{2}$ ") gypsum wallboard, one-inch (1") nominal thickness tight-fitting wood, one-half-inch ($\frac{1}{2}$ ") thick exterior grade ply-

**Attics: Access,
Area Separations
and Ventilation
(Continued)**

wood, or approved incombustible material, adequately supported.

Openings in the partitions shall be protected by self-closing doors constructed as required for the partitions.

EXCEPTION: Where the entire attic is equipped with an approved automatic fire-extinguishing system, the attic space may be divided into areas not to exceed seven thousand and five hundred square feet (7500 sq. ft.).

(c) **Draft Stops.** Regardless of the Type of Construction, draft stops shall be installed in trussed roofs, between roof and bottom chord of trusses, in all buildings exceeding twenty thousand square feet (20,000 sq. ft.) of floor area. Such draft stops shall divide the under roof area into sections not to exceed twenty thousand square feet (20,000 sq. ft.). Draft stops shall be constructed as for attic area separations, and in accordance with the Type of Construction.

(d) **Ventilation.** Enclosed attics shall have clear ventilation area to the outside of not less than one square inch (1 sq. in.) per ten square feet (10 sq. ft.) of horizontal attic area.

Roof Drainage

Sec. 3206. Roof drainage water from a building shall not be permitted to flow over the public sidewalk. Buildings of Group I or J Occupancies may be exempted from this provision.

Roof drains shall be installed when required at each low point of the roof to which the water drains, and shall be adequate in size to drain the roof.

Overflow drains shall be installed when required with the inlet flow line located two inches (2") above the low point of the roof, or overflow scuppers may be installed in parapet walls at each low point of the roof with the flow line not more than two inches (2") above the adjacent roof.

Concealed roof drainage pipe shall be installed as required for soil, waste, or vent piping.

Flashing

Sec. 3207. At the juncture of the roof and vertical surfaces, flashing and counterflashing shall be provided as required in Section 1707 (b).

For roof valley flashing see Section 3203 (d).

CHAPTER 33—STAIRS, EXITS AND OCCUPANT LOADS

Sec. 3301. (a) **Purpose.** The purpose of this Chapter is to determine occupant loads and to provide minimum standards of egress facilities for occupants of buildings, reviewing stands, bleachers and grandstands. **General**

(b) **Scope.** Every building or portion thereof shall be provided with exits as required by this Chapter. Where there is a conflict between a general requirement and a specific requirement for an individual occupancy, the specific requirement shall be applicable.

(c) **Definitions.** For the purpose of this Chapter, certain terms are defined as follows:

BALCONY, EXTERIOR EXIT, is a landing, or porch projecting from the wall of a building, and which serves as a required means of egress. The long side shall be at least 50 per cent open, and the open area above the guardrail shall be so distributed as to prevent the accumulation of smoke or toxic gases.

EXIT is a continuous and unobstructed means of egress to a public way, and shall include intervening doors, doorways, corridors, exterior exit balconies, ramps, stairways, smoke-proof enclosures, horizontal exits, exit passageways, exit courts, and yards.

EXIT COURT is a yard or court providing egress to a public way for one or more required exits.

EXIT PASSAGEWAY is an enclosed means of egress connecting a required exit or exit court with a public way.

HORIZONTAL EXIT is a means of passage from one building into another building occupied by the same tenant, or from one section of a building into another section of the same building occupied by the same tenant, through a separation wall having a minimum fire resistance of one hour.

OCCUPANT LOAD is the total number of persons that may occupy a building or portion thereof at any one time.

PANIC HARDWARE is a bar which extends across at least one-half the width of each door leaf, which will open the door if subjected to pressure.

PRIVATE STAIRWAY is a stairway serving one tenant only.

PUBLIC WAY is any parcel of land unobstructed from the ground to the sky, more than ten feet (10') in width, appropriated to the free passage of the general public.

(d) **Determination of Occupant Load.** The occupant load permitted in any building or portion thereof shall be deter-

General
(Continued)

mined by dividing the floor area assigned to that use by the square feet per occupant as set forth in Table No. 33-A.

When the square feet per occupant are not given for a particular occupancy it shall be determined by the Building Official, based on the area given for the occupancy which it most nearly resembles.

EXCEPTIONS: 1. The occupant load of an area having fixed seats shall be determined by the number of fixed seats installed. Aisles serving the fixed seats and not used for any other purpose shall not be assumed as adding to the occupant load.

2. The occupant load permitted in a building or portion thereof may be increased above that specified in this Section if the necessary exits are provided. An approved aisle or seating diagram may be required by the Building Official to substantiate an increase in occupant load.

In determining the occupant load, all portions of a building shall be presumed to be occupied at the same time.

EXCEPTION: Accessory use areas which are ordinarily used only by persons who occupy the main areas of an occupancy shall be provided with exits as though they were completely occupied, but their occupant load need not be included in computing the total number of occupants for the building.

(e) **Overcrowding.** The number of occupants of any building or portion thereof shall not exceed the permitted or posted capacity.

(f) **Benches, Pews, Booths.** Where benches or pews are used, the number of seats shall be based on one person for each eighteen inches (18") of length of the pews or benches. Where booths are used in dining areas, the number of seats shall be based on one person for each twenty-four inches (24") or major portion thereof of length of booth.

(g) **Mixed Occupancies.** The capacity of a building containing mixed occupancies shall be determined by adding the number of occupants of the various portions as set forth in Table No. 33-A.

(h) **More Than One Purpose.** For determining exit requirements the capacity of a building or portion thereof which is used for different purposes, shall be determined by the occupant load which gives the largest number of persons.

(i) **Exit Obstruction.** No obstructions shall be placed in the required width of an exit except projections permitted by this Chapter.

(j) **Posting of Room Capacity.** Any room having an occupant load of more than 50 where fixed seats are not installed, and which is used for classroom, assembly, or similar purpose,

shall have the capacity of the room posted in a conspicuous place near the main exit from the room. Approved signs shall be maintained in a legible manner by the owner or his authorized agent, and shall indicate the number of occupants permitted for each room use.

**General
(Continued)**

(k) **Changes in Elevation.** Except in Group I Occupancies, changes in elevation of less than twelve inches (12") along any exit serving a tributary occupant load of 10 or more, shall be by means of ramps.

Sec. 3302. (a) Number of Exits. Every building or usable portion thereof shall have at least one exit, and shall have not less than two exits where required by Table No. 33-A. **Exits Required**

In all occupancies, areas above the first story having an occupant load of more than 10 shall have not less than two exits.

Each mezzanine used for other than storage purposes, if greater in area than two thousand square feet (2000 sq. ft.), or if more than sixty feet (60') in any dimension shall have not less than two stairways to an adjacent floor.

For special requirements for Groups A, B, C, D, E, H, and I Occupancies, see Sections 3315, 3316, 3317, 3318, 3319, and 3320.

Every story or portion thereof, having an occupant load of 500 to 999 shall have not less than three exits.

Every story or portion thereof, having an occupant load of 1000 or more shall have not less than four exits.

The number of exits required from any story of a building shall be determined by using the occupant load of that story, plus the percentages of the occupant loads of floors which exit through the level under consideration as follows:

1. Fifty per cent of the occupant load in the first adjacent story above (and the first adjacent story below, when a story below exits through the level under consideration).

2. Twenty-five per cent of the occupant load in the story immediately beyond the first adjacent story.

The maximum number of exits required for any story shall be maintained until egress is provided from the structure. (See Section 3311.)

For purposes of this Section, basements or cellars and occupied roofs shall be provided with exits as required for stories. Floors above the second story, basements and cellars used for other than service of the building shall have not less than two exits.

(b) **Width.** The total width of exits in feet shall be not less than the total occupant load served divided by 50. Such width of exits shall be divided approximately equally among the separate exits.

**Exits Required
(Continued)**

The total exit width required from any story of a building shall be determined by using the occupant load of that story, plus the percentages of the occupant loads of floors which exit through the level under consideration as follows:

1. Fifty per cent of the occupant load in the first adjacent story above (and the first adjacent story below, when a story below exits through the level under consideration).

2. Twenty-five per cent of the occupant load in the story immediately beyond the first adjacent story.

The maximum exit width required from any story of a building shall be maintained.

(c) **Arrangement of Exits.** If only two exits are required they shall be placed a distance apart equal to not less than one-fifth of the perimeter of the area served measured in a straight line between exits. Where three or more exits are required they shall be arranged a reasonable distance apart so that if one becomes blocked others will be available.

(d) **Distance to Exits.** No point in an unsprinklered building shall be more than one hundred and fifty feet (150') from an exterior exit door, a horizontal exit, exit passageway or an enclosed stairway, measured along the line of travel.

In a building equipped with a complete automatic fire-extinguishing system the distance from exits may be increased to two hundred feet (200').

Doors

Sec. 3303. (a) General. This Section shall apply to every exit door serving an area having an occupant load of more than 10, or serving hazardous rooms or areas. Subsections (h) and (i) shall apply to all doors, regardless of occupant load.

(b) **Swing.** Exit doors shall swing in the direction of exit travel when serving any hazardous area or when serving an occupant load of 50 or more.

Double acting doors shall not be used as exits serving a tributary occupant load of more than 100; nor shall they be used as a part of a fire assembly, nor equipped with panic hardware. A double acting door shall be provided with a view panel of not less than two hundred square inches (200 sq. in.).

(c) **Type of Lock or Latch.** Exit doors shall be openable from the inside without the use of a key or any special knowledge or effort.

EXCEPTION: This requirement shall not apply to exterior exit doors in a Group F or G Occupancy if there is a readily visible, durable sign on or adjacent to the door, stating "THIS DOOR TO REMAIN UNLOCKED DURING BUSINESS HOURS." The sign shall be in letters not less than one inch (1") high on a contrasting background. The locking device must be of a type that will be readily distinguishable as locked. The use of this Exception may be revoked by the Building Official for due cause.

TABLE NO. 33-A—AVAILABLE SQUARE FEET PER OCCUPANT

Use ¹	Minimum of Two Exits Required Where Number of Occupants Is Over	Square Feet Per Occupant
Aircraft Hangars (No repair)	10	500
Auction Rooms	30	7
Assembly Areas, Concentrated Use (without fixed seats)	50	7
Auditoriums		
Bowling Alleys (Assembly areas)		
Churches and Chapels		
Dance Floors		
Lodge Rooms		
Reviewing Stands		
Stadiums		
Assembly Areas, Less-concentrated Use	50	15
Conference Rooms		
Dining Rooms		
Drinking Establishments		
Exhibit Rooms		
Gymnasiums		
Lounges		
Skating Rinks		
Stages		
Children's Homes and Homes for the Aged	5	80
Classrooms	20	20
Dormitories	10	50
Dwellings	10	300
Garage, Parking	30	200
Hospitals and Sanitariums—		
Nursing Homes	5	80
Hotels and Apartments	10	200
Kitchen—Commercial	30	200
Library Reading Room	50	50
Locker Rooms	30	50
Mechanical Equipment Room	30	300
Nurseries for Children (Day-care)	5	50
Offices	30	100
School Shops and Vocational Rooms	50	50
Stores—Retail Sales Rooms		
Basement	50	20
Ground Floor	50	30
Upper Floors	10	50
Warehouses	30	300
All Others	50	100

¹Refer to Sections 3318, 3319, 3320 for other specific requirements.

Flush bolts or surface bolts are prohibited.

EXCEPTION: Surface bolts of not less than one-half-inch ($\frac{1}{2}$ ") half round stock with a three-fourths-inch ($\frac{3}{4}$ ") minimum diameter control knob may be permitted. There shall be no more than two such surface bolts to an exit opening and they shall be readily accessible.

Doors
(Continued)

Doors**(Continued)**

(d) **Width and Height.** Doors required by this Section shall provide a minimum clear width of opening of thirty-four inches (34") and shall have a minimum height of seventy-eight inches (78").

(e) **Door Leaf Width.** No leaf of an exit door shall exceed four feet (4') in width.

(f) **Special Doors.** Revolving, sliding and overhead doors shall not be used as required exits.

(g) **Egress from Door.** Every exit door required by this Section shall give immediate access to an approved means of egress from the building.

(h) **Doors Opening into Stairway.** Regardless of the occupant load, exit doors shall open onto a floor or landing. The floor or landing shall be level with, or not more than two inches (2") lower than the threshold of the doorway.

EXCEPTION: In Group I Occupancies, and within individual units of Group H Occupancies, doors swinging away from the stairs may open on the top step of a flight of stairs without the requirement for a landing. In Group I Occupancies, exterior landings may be not more than seven and one-half inches (7½") below the floor level.

(i) **Door Identification.** Glass doors shall conform to the requirements specified in Section 5406.

Other exit doors shall be so marked that they are readily distinguishable from the adjacent construction.

(j) **Additional Doors.** When additional doors are provided for egress purposes, they shall conform to all provisions of this Chapter.

**Corridors and
Exterior Exit
Balconies**

Sec. 3304. (a) General. This Section shall apply to every corridor and exterior exit balcony serving as a required exit for an occupant load of more than 10. Subsection (e) shall apply regardless of occupant load.

(b) **Width.** Every corridor or exterior exit balcony shall be not less in width than forty-four inches (44"). For special requirements for Groups C and D Occupancies, see Sections 3317. and 3318.

(c) **Projections.** The required width of corridors and exterior exit balconies shall be unobstructed.

EXCEPTION: Trim handrails, and doors when fully opened, shall not reduce the required width by more than seven inches (7"). Doors in any position shall not reduce the required width by more than one-half.

(d) **Access to Exits.** When more than one exit is required, they shall be so arranged that it is possible to go in either direction from any point in a corridor or exterior exit balcony

to a separate exit, except from dead ends permitted by this Section.

(e) **Dead Ends.** Corridors and exterior exit balconies with dead ends are permitted when the dead end does not exceed twenty feet (20') in length.

(f) **Construction.** Walls and ceilings of corridors shall be not less than one-hour fire-resistive construction. Floors, walls, and ceilings of exterior exit balconies shall have the same period of fire resistance as required for the floors, walls and ceilings of the building.

EXCEPTION: This Subsection shall not apply to exterior exit balcony railings, corridors of a one-story building housing a Group F or G Occupancy occupied by one tenant only and which serves an occupant load of 30 or less, nor to corridors formed by temporary partitions regulated by Section 1705 (a).

(g) **Openings.** Where corridor walls are required to be one-hour fire-resistive construction every interior door opening shall be protected as set forth in Table No. 33-B. Other interior openings, except ventilation louvers equipped with approved automatic fire shutters shall be one-fourth-inch ($\frac{1}{4}$ ") fixed wire glass set in steel frames. The total area of all openings other than doors, in any portion of an interior corridor wall shall not exceed 25 per cent of the area of the corridor wall of the room which it is separating from the corridor.

Individual glass lights shall not exceed twelve hundred square inches (1200 sq. in.) and any single window shall not exceed the limits specified in Section 4306 (f), Exception No. 2.

EXCEPTION: In corridors of Groups F and G Occupancies, interior openings may have fixed plain glass as specified in Section 5406 of unlimited area provided the corridors are at least ten feet (10') in width and do not serve as means of egress for other floors in the building. Such corridors shall have exits at each extremity. All portions of the floor served whose occupant loads are tributary to the corridor shall have access to at least one additional exit leading to the exterior of the building except where an approved automatic fire-extinguishing system is installed throughout the story in which such corridors are located.

Openings located between the end of an exterior exit balcony and the nearest stairway shall be protected as required for corridors. Other openings to an exterior exit balcony need not be protected unless required by other provisions of this Code.

Sec. 3305. (a) General. Every stairway serving any building or portion thereof shall conform to the requirements of this Section.

**Corridors and
Exterior Exit
Balconies
(Continued)**

Stairways

EXCEPTION: Stairs or ladders used only to attend equipment are exempt from the requirements of this Section.

TABLE NO. 33-B—REQUIREMENTS FOR DUAL PURPOSE FIRE-EXIT DOORS^{1, 2}

Occupancy	Exit Doors to Corridors			Exit Enclosure			Boiler and Furnace Rooms						Corridors Crossing Area Separation Walls		
							Gas-Fired			Oil or Solid Fuel ³					
	Hour Rating	Glazing Per Leaf (Square Inches)	Closing Device	Hour Rating	Glazing Per Opening (Square Inches)	Closing Device	Hours ⁴ Rating	Glazing (Square Inches)	Closing Device	Hour Rating	Glazing (Square Inches)	Closing Device	Hour Rating	Glazing Per Leaf (Square Inches)	Closing Device
A	¾	720	A or B	1	100	A or B	1	0	A	3	0	A	Not applicable		
B	5	1200	C	1	100	A or B	1	0	A	3	0	A	Not permitted except in combination with Group C Occupancies		
C	5	1200	C	1	100	A or B	1	0	A	3	0	A	1	100	A or B
D-1	¾ ⁶	720	C	1½ ⁷	100	A or B	1	0	A	3	0	A	No exits permitted		
D-2 D-3	5	1200	C	1½ ⁷	100	A or B	1	0	A	3	0	A	1	100	A or B
E-1 -2, -3	¾	100	A or D	1½ ⁷	100	A or B	No interior openings permitted						No exits permitted		
E-4 E-5	¾	100	A or D	1½ ⁷	100	A or B	No interior openings permitted						No exits permitted		
F-1 F-3	¾	100	A or D	1½ ⁷	100	A or B	1	0	A	1½ ⁸	0	A	No exits permitted		

TABLE NO. 33-B—REQUIREMENTS FOR DUAL PURPOSE FIRE-EXIT DOORS^{1, 2} (Continued)

Occupancy	Exit Doors to Corridors			Exit Enclosure			Boiler and Furnace Rooms						Corridors Crossing Area Separation Walls		
							Gas-Fired			Oil or Solid Fuel ³					
	Hour Rating	Glazing Per Leaf (Square Inches)	Closing Device	Hour Rating	Glazing Per Opening (Square Inches)	Closing Device	Hours ⁴ Rating	Glazing (Square Inches)	Closing Device	Hour Rating	Glazing (Square Inches)	Closing Device	Hour Rating	Glazing Per Leaf (Square Inches)	Closing Device
F-2	5	1200	C	1	100	A or B	1	0	A	1½ ³	0	A	No exits permitted		
G	5	1200	C	1	100	A or B	1	0	A	1½ ³	0	A	No exits permitted		
H	5	1200	C	1	100	A or B	1	0	A	3	0	A	No exits permitted		
I	NOT APPLICABLE														

A—Self-closing.

B—Automatic-closing doors shall close automatically when released by activation of a detector set to operate when smoke reduces the intensity of a one-foot (1') long beam of white light by 4 per cent, or any other detection device which will work within that limitation.

C—None required.

D—Automatic-closing at 165°F. fusible link, or equal.

¹For occupancy separations and protection of openings see Table No. 5-B.²For hardware requirements see Section 4306 (e), for glazing see Section 4306 (f).³Where oil-fired boilers are used a six-inch (6") incombustible sill (dike) shall be provided.⁴Mounted within the boiler room.⁵Tight-fitting smoke or draft stop door is required; doors equal to not less than an exterior type solid wood door (without voids, assembled with exterior type glue) one and three-fourths-inch (1¾") minimum thickness with wired glass installed in steel frames. Hardware shall be capable of holding door closed against fire for 25 minutes.⁶Except jails, prisons, etc., where open barred cells are provided.⁷Less than five stories in height, one-hour will be permitted. Smokeproof enclosures shall comply with Section 3309 (e).

**Stairways
(Continued)**

(b) **Width.** Stairways serving an occupant load of more than 50 shall be not less in width than forty-four inches (44"). Stairways serving an occupant load of 50 or less may be thirty-six inches (36") wide. Private stairways serving an occupant load of less than 10 may be thirty inches (30") wide. Trim and handrails shall not reduce the required width by more than three and one-half inches (3½").

(c) **Rise and Run.** The rise of every step in a stairway shall not exceed seven and one-half inches (7½") and the run shall be not less than ten inches (10"). Except as provided under Subsection (d) the maximum variations in the height of risers and the width of treads in any one flight shall be three-sixteenths inch ($\frac{3}{16}$ ").

EXCEPTION: In private stairways serving an occupant load of less than 10 the rise may be eight inches (8") and the run may be nine inches (9").

(d) **Winding and Curved Stairways.** In Group I Occupancies, in private stairways in Group H Occupancies, and in stairways not part of a required exit, winders may be used if the required width of run is provided at a point not more than twelve inches (12") from the side of the stairway where the treads are the narrower, but in no case shall any width of run be less than six inches (6") at any point. Curved stairs may be used as a required exit if complying with requirements for exit stairs, including a minimum ten-inch (10") width of run.

(e) **Landings.** Every landing shall have a dimension measured in the direction of travel equal to the width of the stairway. Such dimension need not exceed four feet (4') when the stair has a straight run. Landings, when provided, shall not be reduced in width by more than three and one-half inches (3½") by a door when fully open. See Section 3303 (h).

(f) **Basement Stairways.** Where a basement stairway and a stairway to an upper story terminate in the same exit enclosure, an approved barrier shall be provided to prevent persons from continuing on into the basement. Directional exit signs shall be provided as set forth in Section 3312 (b).

(g) **Distance Between Landings.** There shall be not more than twelve feet (12') vertically between landings.

(h) **Handrails.** Stairways shall have handrails on each side, and every stairway required to be more than eighty-eight inches (88") in width shall have intermediate handrails dividing the stairway into portions not more than eighty-eight inches (88") in width.

Handrails shall be placed not less than thirty inches (30") nor more than thirty-four inches (34") above the nosing of treads, and ends of handrails shall be returned or shall terminate in newel posts or safety terminals.

EXCEPTIONS: 1. Stairways forty-four inches (44") or less in width and stairways serving Group I Occupancies may have one handrail. **Stairways (Continued)**

2. Handrails shall not be required for private stairways having less than four risers.

(i) **Guardrails.** All unenclosed floor openings, and open and glazed sides of landings and stairs shall be protected by a guardrail or handrail. Guardrails shall be not less than thirty-six inches (36") in height. Intermediate members in open type railings shall be spaced not more than nine inches (9") apart. See Section 3502. See Section 5406 for glass subject to impact hazards.

(j) **Exterior Stairway Protection.** All openings in the exterior wall below or within ten feet (10'), measured horizontally, of an exterior exit stairway serving a building over two stories in height shall be protected by a self-closing fire assembly having a three-fourths-hour fire-resistive rating.

EXCEPTION: Openings may be unprotected when exterior stairways serve exterior exit balconies as specified in Section 3304 (g).

(k) **Stairway Construction—Interior.** Interior stairways shall be constructed as specified in Part V of this Code.

Where there is enclosed usable space under stairs the walls and soffits of the enclosed space shall be protected on the enclosed side as required for one-hour fire-resistive construction. See Section 3308.

(l) **Stairway Construction—Exterior.** Exterior stairs shall be of incombustible material except that on Type III buildings not exceeding two stories in height and on Type V buildings they may be of wood not less than two inches (2") in nominal thickness.

Exterior stairs shall be protected as required for exterior walls due to location on property, as specified in Parts IV and V of this Code.

Where there is enclosed usable space under stairs, the walls and soffits of the enclosed space shall be protected on the enclosed side as required for one-hour fire-resistive construction.

(m) **Stairway to Roof.** In every building more than two stories in height, one stairway shall extend to the roof surface, unless the roof has a slope greater than four in 12.

(n) **Headroom.** Every required stairway shall have headroom clearance of not less than six feet six inches (6'6") measured vertically from the nearest nosing to the nearest soffit.

Sec. 3306. (a) General. A ramp conforming to the requirements of this Section may be used as an exit. **Ramps**

**Ramps
(Continued)**

(b) **Width.** The width of ramps shall be as required for corridors.

(c) **Slope.** The slope of a ramp shall not exceed one foot (1') in eight feet (8').

(d) **Handrails.** A ramp with slope exceeding one foot (1') in ten feet (10') shall have handrails as required for stairways, except that intermediate handrails shall not be required.

(e) **Construction.** Ramps shall be constructed as required for stairways.

(f) **Surface.** The surface of ramps shall be roughened or shall be of nonslip materials.

Horizontal Exit

Sec. 3307. (a) **Used as a Required Exit.** If conforming to the provisions of this Chapter, a horizontal exit may be considered as a required exit.

(b) **Openings.** All openings in a separation wall shall be protected by a fire assembly having a fire-resistive rating of not less than one hour.

(c) **Discharge Areas.** A horizontal exit shall lead into a floor area having capacity for an occupant load not less than the occupant load served by such exit. The capacity shall be determined by allowing three square feet (3 sq. ft.) of net clear floor area per ambulatory occupant and twenty square feet (20 sq. ft.) per nonambulatory occupant. The area into which the horizontal exit leads shall be provided with exits other than additional horizontal exits as required by Section 3302.

Exit Enclosures

Sec. 3308. (a) **General.** Every interior stairway, ramp, or escalator shall be enclosed as specified in this Section.

EXCEPTIONS: 1. In other than Group D Occupancies, an enclosure will not be required for a stairway, ramp, or escalator serving only one adjacent floor and not connected with corridors or stairways serving other floors. For enclosure of escalators serving Groups F and G Occupancies, see Chapter 30.

2. Stairs in Group I Occupancies need not be enclosed.

(b) **Enclosure Construction.** Enclosure walls shall be of not less than two-hour fire-resistive construction in buildings more than four stories in height and shall be of not less than one-hour fire-resistive construction elsewhere.

(c) **Openings into Enclosures.** There shall be no openings into exit enclosures except exit doorways and openings in exterior walls. All exit doors in an exit enclosure shall be protected as set forth in Table No. 33-B.

(d) **Extent of Enclosure.** Stairway and ramp enclosures shall include landings and parts of floors connecting stairway

flights and shall also include a corridor on the ground floor leading from the stairway to the exterior of the building. Enclosed corridors or passageways are not required from unenclosed stairways.

**Exit Enclosures
(Continued)**

(e) **Barrier.** A stairway in an exit enclosure shall not continue below the grade level exit unless an approved barrier is provided at the ground floor level to prevent persons from accidentally continuing into the basement.

(f) **Use of Space Under Stair.** There shall be no enclosed usable space under stairways in an exit enclosure, nor shall the open space under such stairways be used for any purpose.

Sec. 3309. (a) General. A smokeproof enclosure shall consist of a continuous stairway enclosed from the highest point to the lowest point by walls of two-hour fire-resistive construction. The supporting structural frame shall be protected as set forth in Table No. 17-A.

**Smokeproof
Enclosures**

(b) **Where Required.** In buildings five stories or more in height, one of the required exits shall be a smokeproof enclosure.

(c) **Construction.** Stairs in smokeproof enclosures shall be of incombustible construction.

(d) **Openings and Access.** There shall be no openings in smokeproof enclosures, except exit doorways and openings in exterior walls. There shall be no opening directly into the interior of the building. Access shall be through a vestibule with one wall at least 50 per cent open to the exterior and having an exit door from the interior of the building and an exit door leading to the smokeproof enclosure. In lieu of a vestibule, access may be by way of an open exterior balcony of incombustible materials.

(e) **Doors.** The opening from the building to the vestibule or balcony shall be protected with a self-closing fire assembly having a one-hour fire-resistive rating. The opening from the vestibule or balcony to the stair tower shall be protected by a self-closing fire assembly having a one-hour fire-resistive rating.

(f) **Outlet.** A smokeproof enclosure shall exit into a public way or into an exit passageway leading to a public way. The exit passageway shall be without other openings and shall have walls, floors and ceilings of two-hour fire resistance.

(g) **Barrier.** A stairway in a smokeproof enclosure shall not continue below the grade level exit unless an approved barrier is provided at the ground floor level to prevent persons from accidentally continuing into the basement.

Sec. 3310. Every exit shall discharge into a public way, exit court, or exit passageway.

Exit Outlets

**Exit Courts
and Exit
Passageways**

Sec. 3311. (a) Discharge. Every exit court shall discharge into a public way, or exit passageway. Passageways shall be without openings other than required exits and shall have walls, floors and ceilings of the same period of fire resistance as the walls, floors and ceilings of the building but shall be not less than one-hour fire-resistive construction.

(b) Width. Every exit court and exit passageway shall be at least as wide as the required total width of the tributary exits, such required width being based on the occupant load served.

The required width of exit courts or exit passageways shall be unobstructed except as permitted in corridors. See Section 3304 (c).

At any point where the width of an exit court is reduced from any cause, the reduction in width shall be effected gradually by a guardrail at least three feet (3') in height. The guardrail shall make an angle of not more than 30 degrees with the axis of the exit court.

(c) Slope. The slope of exit courts shall not exceed one in 10. The slope of exit passageways shall not exceed one in eight. For handrail requirements see Section 3306 (d).

(d) Number of Exits. Every exit court shall be provided with exits as required by Section 3302.

(e) Openings. All openings into an exit court less than ten feet (10') wide shall be protected by fire assemblies having a three-fourths-hour fire-resistive rating.

EXCEPTION: Openings more than ten feet (10') above the floor of the exit court may be unprotected.

**Exit Signs and
Illumination**

Sec. 3312. (a) Exit Illumination. Exits shall be illuminated at any time the building is occupied with light having an intensity of not less than one-foot candle at floor level.

EXCEPTION: Group I Occupancies.

Exit illumination shall be provided with separate circuits or separate sources of power (but not necessarily separate from exit signs) when these are required for exit sign illumination. See Section 3312 (c).

(b) Exit Signs. At every required exit doorway, and wherever otherwise required to clearly indicate the direction of egress, an exit sign with letters at least five inches (5") high shall be provided from all areas serving the occupant load specified in this Subsection. In interior stairways the floor level leading direct to the exterior shall be clearly indicated.

Group A Occupancies and Groups B, D and H Occupancies with an occupant load of more than 50.

All other occupancies serving an occupant load of more than 100.

EXCEPTION: Main exterior exit doors which obviously and clearly are identifiable as exits need not be sign posted when approved by the Building Official.

**Exit Signs and
Illumination
(Continued)**

(c) **Illumination of Signs.** Exit signs serving the occupant loads specified in this Subsection shall be lighted with two electric lamps of not less than 15 watts each in the following manner:

1. Two separate sources of supply shall be provided for the following occupancies:

- A. Group A Occupancies.
- B. Divisions 1 and 2 of Group B Occupancies with an occupant load over 500 persons, except churches with an occupant load of less than 750 persons.
- C. Group D Occupancies with an occupant load over 100 persons.

2. Separate circuits, one of which shall be separated from all other circuits in the building and independently controlled, shall be required for the following occupancies:

- A. Groups B, C, F and G Occupancies with an occupant load over 300 persons.
- B. Groups E and H Occupancies with an occupant load over 100 persons.
- C. Group D Occupancies with an occupant load over 50 persons.

Sec. 3313. (a) General. Every portion of every building in which are installed seats, tables, merchandise, equipment or similar materials shall be provided with aisles leading to an exit. **Aisles**

(h) **Width.** Every aisle shall be not less than three feet (3') wide if serving only one side, and not less than three feet six inches (3'6") wide if serving both sides. Such minimum width shall be measured at the point farthest from an exit, cross aisle, or foyer and shall be increased by one and one-half inches (1½") for each five feet (5') in length toward the exit, cross aisle, or foyer.

With continental spacing, as set forth in Section 3314 (a), side aisles shall be not less than forty-four inches (44") in width.

(c) **Distances to Nearest Exit.** In areas occupied by seats, and in Groups A and B Occupancies without seats, the line of travel to an exit door by an aisle shall be not more than one hundred and fifty feet (150').

(d) **Aisle Spacing.** With standard spacing, as set forth in Section 3314 (a), aisles shall be so located that there will be not more than six intervening seats between any seat and the nearest aisle.

With continental spacing, as set forth in Section 3314 (a), the number of intervening seats may be increased to 29 where

Aisles**(Continued)**

exit doors are provided along each side aisle of the row of seats at the rate of one pair of exit doors for each five rows of seats. Such exit doors shall provide a minimum clear width of sixty-six inches (66").

(c) **Cross Aisles.** Aisles shall terminate in a cross aisle, foyer, or exit. The width of the cross aisle shall be not less than the sum of the required width of the widest aisle plus 50 per cent of the total required width of the remaining aisles leading thereto. In Groups A, B, and C Occupancies, aisles shall not provide a dead end greater than twenty feet (20') in length.

(f) **Vomitories.** Vomitories connecting the foyer or main exit with the cross aisles shall have a total width not less than the sum of the required width of the widest aisle leading thereto plus 50 per cent of the total required width of the remaining aisles leading thereto.

(g) **Slope.** The slope portion of aisles shall not exceed one foot (1') fall in eight feet (8').

Seats

Sec. 3314. (a) Seat Spacing. With standard seating the spacing of rows of seats from back-to-back shall be not less than thirty-three inches (33"), nor less than twenty-seven inches (27") plus the sum of the thickness of the back and inclination of the back.

With continental seating, the spacing of rows of unoccupied seats shall provide a clear width measured horizontally as follows (automatic or self-rising seats shall be measured in the seat-up position, other seats shall be measured in the seat-down position):

Eighteen inches (18") clear for rows of 18 seats or less

Twenty inches (20") clear for rows of 35 seats or less

Twenty-one inches (21") clear for rows of 45 seats or less

Twenty-two inches (22") clear for rows of 46 seats or more

(b) **Width.** The width of any seat shall be not less than eighteen inches (18").

(c) **Bleacher Seats.** Seats used in grandstands, bleachers and reviewing stands shall conform to Section 3322.

Exits: Group A Occupancies

Sec. 3315. (a) Main Exit. Every Group A Occupancy shall be provided with a main exit.

The main exit shall be of sufficient width to accommodate one-half of the total occupant load but shall be not less than the total required width of all aisles, exit passageways, and stairways leading thereto, and shall connect to a stairway or ramp leading to a public way.

(b) **Side Exits.** Every auditorium and balcony of a Group A Occupancy shall be provided with exits on each side. The

exits on each side of the auditorium or balcony shall be of sufficient width to accommodate one-third of the total occupant load served. Side exits shall open directly to a public way or into an exit court, enclosed stairway, exterior stairway or exit passageway leading to a public way. Side exits shall be accessible from a cross aisle or a side aisle.

(c) **Panic Hardware.** An exit door from a Group A Occupancy having an occupant load of more than 100 shall not be provided with a latch or lock unless it is panic hardware.

Sec. 3316. (a) Group B, Divisions 1, 2 and 3. Group B, Divisions 1 and 2 Occupancies shall have exits as required by Section 3315. In Group B, Division 3 Occupancies having an occupant load of more than 100, exit doors shall not be provided with a latch or lock unless it is panic hardware.

**Exits: Group B
Occupancies**

EXCEPTION: Group B, Division 2 and 3 Occupancies, such as restaurants, bars, bowling alleys, auditoriums and similar commercial uses, and in churches, panic hardware may be omitted from the main exit when the main exit consists of a single door or one pair of doors. A key locking device may be used in place of the panic hardware provided there is a readily visible metallic sign adjacent to the doorway stating "THIS DOOR MUST REMAIN UNLOCKED DURING BUSINESS HOURS." The sign shall be in letters not less than one inch (1") high on a contrasting background. When unlocked, a single door and each leaf of a pair of doors must be free to swing without operation of any latching device. The locking device on a pair of doors must be arranged so that when one leaf is unlocked, the other is free to swing. Flush, edge or surface bolts or any other type of device that may be used to close or restrain the doors other than by operation of the locking device are prohibited. The use of this Exception may be revoked by the Building Official for due cause.

(b) **Group B, Division 4.** In Group B, Division 4 Occupancies having an occupant load of more than 100, exit doors shall not be provided with a latch or lock unless it is panic hardware. Panic hardware may be waived on gates surrounding stadiums, when the gates are under constant immediate supervision while the public is present and provided safe dispersal areas based upon three square feet (3 sq. ft.) per occupant are located between the stadium and the fence. The required dispersal area shall be located not less than fifty feet (50') from the stadium. See Section 3322 for exits from dispersal areas.

(c) **Skating Rinks.** Skating rinks shall be located at or near the adjacent ground level and exits shall be by means of ramps.

Sec. 3317. (a) Corridors and Exterior Exit Balconies. The width of a corridor in a Group C Occupancy shall be the

**Exits: Group C
Occupancies**

**Exits: Group C
Occupancies
(Continued)**

width required by Section 3302 plus two feet (2') but no corridor shall be less than six feet (6') wide.

Corridor walls and ceilings shall be of not less than one-hour fire-resistive construction.

There shall be no change of elevation of less than two feet (2') in a corridor or exterior exit balcony unless ramps are used.

(b) **Exits Serving Auditoriums.** An exit serving both an auditorium and other rooms need provide only for the capacity of whichever requires the greater width if the auditorium is not to be used simultaneously with the other rooms.

(c) **Stairs.** Each floor above or below the ground floor level shall have not less than two exit stairs and the required exit width shall be equally divided between such stairs, provided that no stair serving an occupant load of more than 100 shall be less than five feet (5') in clear width.

EXCEPTION: This Subsection does not apply to rooms used for maintenance, storage, and similar purposes.

(d) **Doors.** The width of exit doors from corridors, halls and stairs shall be not more than two feet (2') narrower than the width required by Section 3317 (a).

Exit doors in school rooms having an occupant load of more than 20 shall swing in the direction of egress.

(e) **Rooms Below Grade.** One exit accessible to every room below grade shall lead directly to the exterior at grade level.

(f) **Panic Hardware.** Exit doors from rooms having an occupant load of more than 100 and from corridors shall not be provided with a latch or lock unless it is panic hardware.

(g) **Fences and Gates.** School grounds may be fenced in and gates equipped with locks provided safe dispersal areas located not less than fifty feet (50') from the buildings are available for persons between buildings and fence. Dispersal areas shall be based upon an area of not less than three square feet (3 sq. ft.) per occupant. Gates shall not be permitted across corridors or passageways leading to such dispersal areas unless they comply with exit requirements. See Section 3322 for exits from dispersal areas.

**Exits: Group D
Occupancies**

Sec. 3318. (a) Separate Access. Every room in a Group D Occupancy shall have access to at least two approved means of egress from the building without passage through intervening rooms other than corridors or lobbies. All required exterior exit doors shall open in direction of exit travel.

(b) **Minimum Size of Exits.** Every exit opening through which patients are transported in wheelchairs, stretchers or beds shall be of sufficient width to permit the ready passage of such equipment, but shall have a clear width of not less than forty-four inches (44"). There shall be no projections within the forty-four-inch (44") clear width.

(c) **Corridors.** The minimum clear width of a corridor shall be forty-four inches (44"), except that corridors serving any area housing one or more nonambulatory persons shall be not less than eight feet (8') in width. There shall be no change of elevation in a corridor serving nonambulatory persons unless ramps are used.

**Exits: Group D
Occupancies
(Continued)**

(d) **Basement Exits.** One exit accessible to every room below grade shall lead directly to the exterior at grade level.

(e) **Ramps.** Every portion of Group D, Division 2 Occupancies housing bedridden patients shall have access to a horizontal exit or ramp leading to the exterior of the building at the ground floor level.

(f) **Hardware.** Exit doors serving an occupant load of more than 50 shall not be provided with a latch or lock unless it is panic hardware. Patient room doors shall be readily openable from either side without the use of keys.

EXCEPTION: No requirements of this Chapter shall be so construed as to prohibit the construction of cell blocks in jails, or prevent the use of any locks or safety devices where it is necessary to forcibly restrain the inmates.

Sec. 3319. Every portion of a Group E Occupancy having a floor area of two hundred square feet (200 sq. ft.) or more shall be served by at least two separate exits.

**Exits: Group E
Occupancies**

In Divisions 1 and 2, no part of any room shall be more than seventy-five feet (75') from an exit.

Sec. 3320. Every sleeping room below the fourth floor in Groups H and I Occupancies shall have at least one openable window to permit emergency exit or rescue. Such window shall have a sill height of not more than forty-eight inches (48") above the floor and shall provide not less than five square feet (5 sq. ft.) of openable area with no dimension less than twenty-four inches (24").

**Exits: Groups
H and I
Occupancies**

Sec. 3321. (a) Boiler Rooms. Except in Group I Occupancies, every boiler room and every room containing an incinerator or L-P Gas or liquid fuel-fired equipment, shall be provided with at least two means of egress, one of which may be a ladder. All interior openings shall be protected as set forth in Table No. 33-B.

Special Hazards

(b) **Cellulose Nitrate Handling.** Film laboratories, projection rooms, and nitrocellulose processing rooms shall have not less than two exits.

Sec. 3322. (a) Scope. All reviewing stands, grandstands and bleachers shall conform to the provisions of this Section.

**Reviewing Stands,
Grandstands
and Bleachers**

(b) **Definitions.** For the purpose of this Section certain terms are defined as follows:

**Reviewing Stands,
Grandstands
and Bleachers
(Continued)**

EXIT. Exit shall be deemed to be that point which opens directly into a safe dispersal area or public way. All measurements are to be made to that point when determining the permissible distance of travel.

SAFE DISPERSAL AREA. Safe dispersal area shall mean an area which will accommodate a number of persons equal to the total capacity of the stand and building it serves, in such a manner that no person within the area need be closer than fifty feet (50') from the stand or building. Dispersal areas shall be based upon an area of not less than three square feet (3 sq. ft.) per person.

(c) **Height of Stands.** Stands employing combustible framing shall be limited to 11 rows or nine feet (9') in height.

(d) **Design Requirements.** The minimum unit live load for reviewing stands, grandstands, and bleachers shall be 100 pounds per square foot of horizontal projection for the structure as a whole. Seat and footboards shall be 120 pounds per lineal foot. The sway force, applied to seats, shall be 24 pounds per lineal foot parallel to the seats, and 10 pounds per lineal foot perpendicular to the seats. Sway forces need not be applied simultaneously with other lateral forces.

(e) **Spacing of Seats.** 1. **Row spacing.** The minimum spacing of rows of seats measured from back to back shall be: Twenty-two inches (22") for seats without backrests in open air stands; thirty inches (30") for seats with backrests, and thirty-three inches (33") for chair seating.

There shall be a space of not less than twelve inches (12") between the back of each seat and the front of the seat immediately behind it.

2. **Rise between rows.** The maximum rise from one row of seats to the next shall not exceed sixteen inches (16").

3. **Seating capacity.** For determining the seating capacity of a stand, the width of any seat shall be not less than eighteen inches (18") nor more than nineteen inches (19").

4. **Number of seats between aisles.** The number of seats between any seat and an aisle shall not be greater than 15 for open air stands with seats without backrests; nine for open air stands with seats having backrests; nine for seats without backrests within buildings, and six for seats with backrests in buildings.

(f) **Aisles.** 1. **Aisles required.** Aisles shall be provided in all stands.

EXCEPTION: Aisles may be omitted when all of the following conditions exist: 1. Seats are without backrests.

2. The rise from row to row does not exceed twelve inches (12") per row.

3. The number of rows does not exceed 11 in height.

4. The top seating board is not over ten feet (10') above grade.

5. The first seating board is not more than twenty inches (20") above grade.

2. **Obstructions.** No obstruction shall be placed in the required width of any aisle or exitway.

3. **Stairs required.** When an aisle is elevated more than eight inches (8") above grade, the aisle shall be provided with a stairway or ramp whose width is not less than the width of the aisle.

4. **Dead end.** No vertical aisle shall have a dead end more than 16 rows in depth regardless of the number of exits required.

5. **Width.** Aisles shall have a minimum width of forty-two inches (42").

(g) **Stairs and Ramps.** 1. **Scope.** The requirements of this Section shall apply to all stairs and ramps except for portions that pass through the seating area.

2. **Stair rise and run.** The maximum rise of treads shall not exceed eight inches (8") and the minimum width of the run shall be eleven inches (11"). The maximum variations in the width of treads in any one flight shall not be more than three-sixteenths inch ($\frac{3}{16}$ ") and the maximum variation in the height of two adjacent risers shall not exceed three-sixteenths inch ($\frac{3}{16}$ ").

3. **Ramp slope.** The slope of a ramp shall not exceed one foot (1') in eight feet (8'). Ramps shall be roughened or shall be of approved nonslip material.

4. **Handrails.** A ramp with a slope exceeding one foot (1') in ten feet (10') shall have handrails. Stairs from stands shall have handrails. Handrails shall conform to Section 3305 (h).

(h) **Guardrails.** Guardrails shall be required in all locations where the top of a seat plank is more than four feet (4') above the grade and at the front of stands elevated more than two feet (2') above grade. Where only sections of stands are used, guardrails shall be provided as required in this Section.

Railings shall be forty-two inches (42") above the rear of a seat plank or forty-two inches (42") above the rear of the steps in an aisle when the guardrail is parallel and adjacent to the aisle.

EXCEPTION: The height may be reduced to thirty-six inches (36") for guardrails located in front of the grandstand.

A midrail shall be placed adjacent to any seat to limit the open distance above the top of any part of a seat to ten inches (10") where the seat is at the extreme end or at the extreme rear of the bleachers or grandstand. The intervening space shall have one additional rail midway in the opening.

**Reviewing Stands,
Grandstands
and Bleachers
(Continued)**

**Reviewing Stands,
Grandstands
and Bleachers
(Continued)**

EXCEPTION: Railings may be omitted when stands are placed directly against a wall or fence giving equivalent protection.

Stairs and ramps shall be provided with guardrails.

Handrails at the front of stands and adjacent to an aisle shall be designed to resist a load of 50 pounds per lineal foot applied at the top rail. Other handrails shall be designed to resist a load of 20 pounds.

(i) **Footboards.** Footboards shall be provided for all rows of seats above the third row, or beginning at such point where the seating plank is more than two feet (2') above grade.

EXCEPTION: Where the same level is used for both seats and footrests, and these levels are not less than twenty-two inches (22") in width, footrests will not be required.

(j) **Exits. 1. Distance to exit.** The line of travel to an exit shall be not more than one hundred and fifty feet (150'). For stands with seats without backrests this distance may be measured by direct line from a seat to the exit from the stand.

2. Aisle used as exit. An aisle may be considered as only one exit unless it is continuous at both ends to a legal building exit or to a safe dispersal area.

3. Two exits required. A stand with the first seating board not more than twenty inches (20") above grade or floor may be considered to have two exits when the bottom of the stand is open at both ends.

Every stand or section of a stand within a building shall have at least two means of egress when the stand accommodates more than 50 persons.

Every open air stand having seats without backrests shall have at least two means of egress when the stand accommodates more than 300 persons.

4. Three exits required. Three exits shall be required for stands within a building when there are more than 300 occupants within a stand, and for open air stands with seats without backrests where a stand or section of a stand accommodates more than 1000 occupants.

5. Four exits required. Four exits shall be required when a stand or section of a stand accommodates more than 1000 occupants.

EXCEPTION: For an open air stand with seats without backrests four exits need not be provided unless there are accommodations for more than 3000 occupants.

6. Determination of exit width. The total width of exits in feet shall be not less than the total occupant load served divided by 50.

EXCEPTION: For open air stands with seats without backrests the total width of exits in feet shall be not less than the total occupant load served divided by 150 when exiting by stairs, and divided by 200 when exiting by ramps or horizontally. When both horizontal and stair exits are used, the total width of exits shall be determined by using both figures as applicable.

7. **Minimum exit width.** No exit shall be less than forty-two inches (42") in width.

8. **Exit arrangement.** Exits shall be arranged a reasonable distance apart. When but two exits are provided, they shall be spaced not less than one-fifth of the perimeter apart.

(k) **Securing of Chairs.** 1. **Raised stands.** Chairs and benches used on raised stands shall be secured to the platforms upon which they are placed.

EXCEPTION: When less than 25 chairs are used upon a single raised platform the fastening of seats to the platform may be omitted.

2. **Ground seats.** When more than 500 loose chairs are used in connection with athletic events, chairs shall be fastened together in groups of not less than three, and shall be tied or staked to the ground.

(l) **Dispersal Area Exits.** Each safe dispersal area shall have at least two exits. If more than 6000 persons are to be accommodated within such an area, there shall be a minimum of three exits, and for more than 9000 persons there shall be at least four exits. The aggregate clear width of exits from a safe dispersal area shall be determined on the basis of not less than one exit unit of twenty-two inches (22") for each 500 persons to be accommodated and no exit shall be less than forty-four inches (44") in width. Exits shall be a reasonable distance apart but shall be spaced not less than one-fifth of the perimeter of the area apart from each other.

**Reviewing Stands,
Grandstands
and Bleachers
(Continued)**

CHAPTER 34—SKYLIGHTS

Skylights

Sec. 3401. Except for Groups I and J Occupancies all skylights shall be constructed with metal frames. Frames of skylights shall be designed to carry loads required for roofs as specified in Section 2305. All skylights, the glass of which is set at an angle of less than 45 degrees from the horizontal, if located above the first story, shall be set at least four inches (4") above the roof. The curbs on which the skylight rests shall be constructed as required for inner court walls or for masonry.

Spacing between supports in one direction for flat wired glass in skylights shall not exceed twenty-five inches (25"). Corrugated wired glass may have supports five feet (5') apart in the direction of the corrugation. All glass in skylights shall be wire glass, except that skylights over vertical shafts extending through two or more stories shall be glazed with plain glass as specified in this Section; provided, that wire glass may be used if ventilation equal to not less than one-eighth the cross-sectional area of the shaft but never less than four feet (4') is provided at the top of such shaft.

Any glass not wire glass shall be protected above and below with a screen constructed of wire not smaller than No. 12 U. S. gauge with a mesh not larger than one inch (1"). The screen shall be substantially supported below the glass.

Skylights installed for the use of photographers may be constructed of metal frames and plate glass without wire netting.

Ordinary glass may be used in the roofs and skylights for greenhouses, provided the height of the greenhouse at the ridge does not exceed twenty feet (20') above the grade. The use of wood in the frames of skylights will be permitted in greenhouses outside of Fire Zones No. 1 and No. 2 if the height of the skylight does not exceed twenty feet (20') above the grade, but in other cases metal frames and metal sash bars shall be used.

Glass used for the transmission of light, if placed in floors or sidewalks, shall be supported by metal or reinforced concrete frames, and such glass shall be not less than one-half inch ($\frac{1}{2}$ ") in thickness. Any such glass over sixteen square inches (16 sq. in.) in area shall have wire mesh embedded in the same or shall be provided with a wire screen underneath as specified for skylights in this Section. All portions of the floor lights or sidewalk lights shall be of the same strength as is required by this Code for floor or sidewalk construction, except in cases where the floor is surrounded by a railing not less than three feet six inches (3'6") in height, in which case the construction shall be calculated for not less than roof loads.

For additional requirements for plastic skylights see Section 5205.

CHAPTER 35—BAYS, PORCHES, AND BALCONIES

Sec. 3501. Construction of walls and floors in bay and oriel windows shall conform to the construction allowed for exterior walls and floors of the type of construction of the building to which they are attached. The roof covering of a bay or oriel window shall conform to the requirements for roofing of the main roof of the building.

**Bay and
Oriel
Windows**

Sec. 3502. Exterior balconies attached to or supported by walls required to be of masonry shall have brackets or beams constructed of incombustible material. Railings shall be provided for balconies, landings, or porches which are more than thirty inches (30") above grade. Such railings shall be not less than thirty-six inches (36") in height above the floor. The intermediate members in open-type railings shall be spaced not more than nine inches (9") apart.

**Balconies
and Porches**

CHAPTER 36—PENTHOUSES AND ROOF STRUCTURES

Penthouses and Roof Structures

Sec. 3601. (a) Height. No penthouse or other projection above the roof in structures of other than Type I construction shall exceed twenty-eight feet (28') in height above the roof when used as an enclosure for tanks or for elevators which run to the roof and in all other cases shall not extend more than twelve feet (12') in height above the roof.

(b) Area. The aggregate area of all penthouses and other roof structures shall not exceed 33⅓ per cent of the area of the supporting roof.

(c) Prohibited Uses. No penthouse, bulkhead, or any other similar projection above the roof shall be used for purposes other than shelter of mechanical equipment or shelter of vertical shaft openings in the roof. Penthouses or bulkheads used for purposes other than permitted by this Section shall conform to the requirements of this Code for an additional story.

(d) Construction. Roof structures shall be constructed with walls, floors, and roof as required for the main portion of the building.

EXCEPTIONS: 1. On Types I and II buildings the exterior walls and roofs of penthouses which are five feet (5') or more from an adjacent property line may be of one-hour fire-resistive incombustible construction.

2. Walls not less than five feet (5') from an exterior wall of a Type III building may be of one-hour fire-resistive incombustible construction.

**Penthouse
and Roof
Structures
(Continued)**

3. Enclosures housing only mechanical equipment and located at least twenty feet (20') from adjacent property lines may be of unprotected incombustible construction.

The restrictions of this Subsection shall not prohibit the placing of wood flagpoles or similar structures on the roof of any building.

**Towers
and
Spires**

Sec. 3602. Towers or spires when enclosed shall have exterior walls as required for the building to which they are attached. Towers not enclosed and which extend more than seventy-five feet (75') above grade shall have their framework constructed of iron, steel, or reinforced concrete. No tower or spire shall occupy more than one-fourth of the street frontage of any building to which it is attached and in no case shall the base area exceed sixteen hundred square feet (1600 sq. ft.) unless it conforms entirely to the type of construction requirements of the building to which it is attached and is limited in height as a main part of the building. If the area of the tower or spire exceeds one hundred square feet (100 sq. ft.) at any horizontal cross section, its supporting frame shall extend directly to the ground. The roof covering of spires shall be as required for the main roof of the rest of the structure.

Skeleton towers used as radio masts and placed on the roof of any building shall be constructed entirely of incombustible materials when more than twenty-five feet (25') in height and shall be directly supported on an incombustible framework to the ground. They shall be designed to withstand a wind load from any direction as specified in Section 2308 in addition to any other loads.

CHAPTER 37—CHIMNEYS, VENTS, FIREPLACES AND BARBECUES

Sec. 3701. (a) General. Included in this Chapter are the **Scope** requirements for chimneys, vents, connectors, fireplaces and barbecues, including their installations and approvals.

(b) Definitions. **BARBECUE** is a stationary open hearth or brazier, either fuel fired or electric, used for food preparation.

CHIMNEY, FACTORY-BUILT is a listed chimney.

CHIMNEY, MASONRY is a chimney of solid masonry units, bricks, stones, listed hollow unit masonry units or reinforced concrete.

CHIMNEY, METAL is a field-constructed chimney of metal.

CHIMNEY CLASSIFICATIONS:

Chimney, Residential Appliance Type is a factory-built or masonry chimney suitable for removing products of combustion from residential type appliances producing combustion gases not in excess of 1000°F. measured at the appliance flue outlet.

Chimney, Low-Heat Appliance Type is a factory-built, masonry or metal chimney suitable for removing the products of combustion from fuel-burning low-heat appliances producing combustion gases not in excess of 1000°F. under normal operating conditions but capable of producing combustion gases of 1400°F. during intermittent forced firing for periods up to one hour. All temperatures are measured at the appliance flue outlet.

Chimney, Medium-Heat Appliance Type is a factory-built, masonry or metal chimney suitable for removing the products of combustion from fuel-burning medium-heat appliances producing combustion gases not in excess of 2000°F. measured at the appliance flue outlet.

Chimney, High-Heat Appliance Type is a factory-built, masonry or metal chimney suitable for removing the products of combustion from fuel-burning high-heat appliances producing combustion gases in excess of 2000°F. measured at the appliance flue outlet.

CHIMNEY CONNECTOR is the pipe used to connect other than listed gas appliances to a chimney.

CHIMNEY LINER is a lining material of fire clay or other approved material that meets the requirements of U.B.C. Standard No. 37-1-64.

EQUIVALENT SOLID THICKNESS is defined in U.B.C. Standard No. 24-4-64.

FIREBRICK is a refractory brick which meets the requirements of U.B.C. Standard No. 37-1-64.

**Scope
(Continued)**

FIREPLACE is a hearth and fire chamber or similarly prepared place in which a fire may be made and which is built in conjunction with a chimney.

LISTED refers to products which are shown in a list published by an approved testing agency, qualified and equipped for experimental testing, and maintaining an adequate periodic inspection of current production of listed models and whose listing states that the product complies with nationally recognized safety requirements.

METAL PIPE, SINGLE WALL is an unlisted sheet metal hollow cylinder used for conveying products of combustion.

POWER EXHAUSTER is a fan installed in or on a chimney, vent, or the connector to a chimney or vent, to induce a draft at the connected appliance and is limited to low- and medium-heat appliances.

VENT is a conduit or passageway, vertical or nearly so, for conveying products of combustion to the outside atmosphere.

VENT CONNECTOR is the pipe used to connect a listed gas appliance to a chimney or vent.

VENTING SYSTEM is the vent, and vent connector if used, assembled to form a continuous open passageway from the appliance to the outside atmosphere for the purpose of removing combustion gases.

KINDS OF VENTING SYSTEMS:

Type B and Type B-W: A gas venting system consisting of vent piping and fittings listed for use with listed gas appliances with draft hoods.

Type B-SS is a venting system consisting of vent piping and fittings listed for use with listed gas appliances or may be used with unlisted residential types of appliances provided the clearances specified in Section 3707 (b) 4 are maintained.

Type L is a venting system consisting of listed vent piping and fittings for use with oil-burning appliances listed for use with Type L or with listed or unlisted gas appliances.

Chimneys

Sec. 3702. (a) Requirements. Every chimney shall be constructed and every venting system shall be installed in accordance with the applicable requirements of this Chapter.

(b) Draft. Every chimney, vent or venting system shall be capable of producing a draft at the appliance not less than that required for the safe operation of the appliance connected thereto.

A power exhauster may be used, except with incinerators, to increase low draft. When an exhauster is used, provision shall be made to shut off the fuel supply to the appliance in the event of failure of the exhauster.

**Chimneys
(Continued)**

(c) **Structural Design.** Chimneys shall be designed, anchored, supported, and reinforced when so designed as required in this Chapter and Chapters 23 and 28. No chimney shall support any structural load other than its own weight unless it is designed to act as a supporting member. Chimneys in wood-frame buildings shall be anchored laterally at the ceiling line and at each floor line which is more than six feet (6') above grade, except when entirely within the framework.

(d) **Walls.** Every masonry chimney shall have walls of masonry units, bricks, stones, listed masonry units, reinforced concrete or equivalent solid thickness of hollow masonry and lined with suitable liners in accordance with the following requirements:

1. **Masonry chimneys for residential-type appliances.** Masonry chimneys shall be constructed of masonry units or reinforced concrete with walls not less than four inches (4") thick or rubble stone masonry not less than twelve inches (12") thick. The chimney liner shall be in accordance with Section 3702 (e).

2. **Masonry chimneys for low-heat appliances.** Masonry chimneys shall be constructed of masonry units or reinforced concrete with walls not less than eight inches (8") thick, except that rubble stone masonry shall be not less than twelve inches (12") thick. The chimney liner shall be in accordance with Section 3702 (e).

3. **Masonry chimneys for medium-heat appliances.** Masonry chimneys for medium-heat appliances shall be constructed of solid masonry units or of reinforced concrete not less than eight inches (8") thick, except that stone masonry shall be not less than twelve inches (12") thick; and, in addition, shall be lined with not less than four inches (4") of firebrick laid in a solid bed of fire clay mortar with solidly filled head, bed and wall joints, starting not less than two feet (2') below the chimney connector entrance and extending for a distance of at least twenty-five feet (25') above the chimney connector entrance. Chimneys extending twenty-five feet (25') or less above the chimney connector shall be lined to the top.

4. **Masonry chimneys for high-heat appliances.** Masonry chimneys for high-heat appliances shall be constructed with double walls of solid masonry units or of reinforced concrete not less than eight inches (8") in thickness, with an air space of not less than two inches (2") between the walls. The inside of the interior walls shall be of firebrick not less than four inches (4") in thickness laid in a solid bed of fire clay mortar with solidly filled head, bed and wall joints.

5. **Masonry chimneys for incinerators installed in multi-story buildings (apartment-type incinerators).** Chimneys for incinerators installed in multistory buildings using the chim-

Chimneys
(Continued)

ney passageway as a refuse chute where the horizontal grate area of combustion chamber does not exceed nine square feet (9 sq. ft.) shall have walls of solid masonry or reinforced concrete, not less than four inches (4") thick with a chimney lining as specified in Subsection (e) of this Section. If the grate area of such an incinerator exceeds nine square feet (9 sq. ft.), walls shall be not less than four inches (4") thick and shall be lined with not less than four inches (4") of firebrick, except that higher than thirty feet (30') above the roof of the combustion chamber, common brick alone, eight inches (8") in thickness, may be used.

6. **Masonry chimneys for commercial and industrial-type incinerators.** Chimneys for commercial and industrial-type incinerators of a size designed for not more than 250 pounds of refuse per hour and having a horizontal grate area not exceeding nine square feet (9 sq. ft.) shall have walls of solid masonry or reinforced concrete not less than four inches (4") thick with lining of not less than four inches (4") of firebrick, which lining shall extend for not less than forty feet (40') above the roof of the combustion chamber. If the design capacity or grate area of such an incinerator exceeds 250 pounds per hour and nine square feet (9 sq. ft.) respectively, walls shall be not less than eight inches (8") thick, lined with not less than four inches (4") of firebrick extending the full height of the chimney.

(e) **Lining.** Fire clay chimney lining shall be not less than five-eighths inch ($\frac{5}{8}$ ") thick. The lining shall extend from eight inches (8") below the lowest inlet or, in the case of fireplaces, from the throat of the fireplace to a point above enclosing masonry walls. Fire clay chimney linings shall be installed ahead of the construction of the chimney as it is carried up, carefully bedded one on the other in fire clay mortar, with close-fitting joints left smooth on the inside. Firebrick not less than two inches (2") thick may be used in place of fire clay chimney lining as set forth in Table No. 37-A.

(f) **Area.** No chimney passageway shall be smaller in area than the vent connection on the appliance attached thereto nor less than as set forth in Table No. 37-A unless engineering methods approved by the Building Official have been used to design the system.

(g) **Height.** Every masonry chimney shall extend at least two feet (2') above the part of the roof through which it passes and at least two feet (2') above the highest elevation of any part of a building within ten feet (10') of the chimney. The Building Official may approve a chimney of lesser height installed with an approved vent cowl having a spark arrester whose opening shall be not less than six feet (6') from any part of the building measured horizontally. For altitudes over two thousand feet (2000') the Building Official shall be consulted in determining the height of the chimney.

**TABLE NO. 37-A—MINIMUM PASSAGEWAY AREAS FOR
MASONRY CHIMNEYS¹**

**Chimneys
(Continued)**

TYPE OF MASONRY CHIMNEY	MINIMUM CROSS-SECTIONAL AREA		
	Round	Square or Rectangle	Lined with Firebrick or Unlined
Residential	50 Sq. in.	50 Sq. in.	85 Sq. in.
Fireplace ²	1/12 of opening Minimum 50 Sq. in.	1/10 of opening Minimum 64 Sq. in.	1/8 of opening Minimum 100 Sq. in.
Low Heat	50 Sq. in.	57 Sq. in.	135 Sq. in.
Incinerator Apartment Type 1 opening 2 to 6 openings 7 to 14 open- ings 15 or more openings	196 Sq. in. 324 Sq. in. 484 Sq. in. 484 Sq. in. plus 10 Sq. in. for each additional opening		Not Applicable

¹Areas for medium- and high-heat chimneys shall be determined using accepted engineering methods and as approved by the Building Official.

²Where fireplaces open on more than one side, the fireplace opening shall be measured along the greatest dimension.

Note: For altitudes over two thousand feet (2000') above sea level, the Building Official shall be consulted in determining the area of the passageway.

(h) **Corbeling.** No masonry chimney shall be corbeled from a wall more than six inches (6"); nor shall a masonry chimney be corbeled from a wall which is less than twelve inches (12") in thickness unless it projects equally on each side of the wall. In the second story of a two-story building of Group I Occupancy, corbeling of masonry chimneys on the exterior of the enclosing walls may equal the wall thickness. In every case the corbeling shall not exceed one-inch (1") projection for each course of brick.

(i) **Change in Size or Shape.** No change in the size or shape of a masonry chimney where the chimney passes through the roof shall be made within a distance of six inches (6") above or below the roof joists or rafters.

(j) **Separation of Masonry Chimney Passageways.** When more than one passageway is contained in the same chimney, masonry separation at least four inches (4") thick bonded into the masonry wall of the chimney shall be provided to separate passageways.

(k) **Inlets.** Every inlet to any masonry chimney shall enter the side thereof and shall be of not less than one-eighth-inch

Chimneys (1/8") thick metal or five-eighths-inch (5/8") thick refractory material.
(Continued)

(l) **Clearance.** Combustible material shall not be placed within two inches (2") of smoke chamber walls or masonry chimney walls when built within a structure, or within one inch (1") when the chimney is built entirely outside the structure. For special conditions covering fireplaces see Section 3711.

(m) **Termination.** All incinerator chimneys shall terminate in a substantially constructed spark arrester having a mesh not exceeding three-fourths inch (3/4").

(n) **Cleanouts.** Cleanout openings shall be provided at the base of every masonry chimney.

Types of Chimneys and Vents Required

Sec. 3703. The type of chimney to serve the various classifications of appliances safely shall be as set forth in Tables No. 37-B and No. 37-C.

Metal Chimneys

Sec. 3704. (a) **Design.** Metal chimneys shall have a minimum thickness equal to No. 10 U. S. gauge steel and shall be designed and constructed as specified in this Chapter, Chapters 23 and 27.

(b) **Construction and Support.** Metal chimneys shall be properly riveted or welded and, unless structurally self-supporting, shall be guyed securely, or firmly anchored to or otherwise supported by the building or structure served thereby.

Metal chimneys used for high-heat appliances shall be lined with four-inch (4") firebrick laid in fire clay mortar extending not less than twenty-five feet (25') above the chimney connector entrance.

(c) **Cleanouts.** Cleanout openings shall be provided at the base of every metal chimney.

(d) **Exterior Chimneys.** Metal chimneys, or parts thereof, erected on the exterior of a building shall have a clearance of at least twenty-four inches (24") from combustible walls and four inches (4") from incombustible walls. No such chimney shall be nearer than twenty-four inches (24") in any direction from a door, window, or other wall opening or from an exit.

(e) **Interior Chimneys.** Metal chimneys, or parts thereof, in a building other than a one-story building, shall be enclosed above the story in which the appliance served thereby is located, in walls of incombustible construction having a fire-resistive rating of not less than one-hour, with a space on all sides between the chimney and the enclosing walls sufficient to render the entire chimney accessible for examination and repair.

The enclosing walls shall be without openings.

EXCEPTION: Doorways equipped with a fire assembly having a one-hour fire-resistive rating may be permitted at each floor level for inspection purposes.

**Metal Chimneys
(Continued)**

Where such a chimney passes through a ceiling or roof constructed of combustible materials, it shall be guarded by an approved ventilating thimble extending not less than nine inches (9") below and nine inches (9") above such ceiling or roof construction. Such thimbles shall be of a size to provide a clearance on all sides of the chimney of not less than eighteen inches (18"); provided that for stacks of low-heat appliances, the clearance may be reduced to not less than six inches (6"). Metal chimneys shall not be carried up inside of ventilating ducts unless such ducts are constructed and installed as required by this Code for chimneys and which are used solely for exhaust of air from the room or space in which the appliances served by the metal chimney are located.

Sec. 3705. (a) Factory-built Chimneys. Factory-built chimneys are listed chimneys and shall be installed in strict accordance with the terms of their listings and the manufacturer's instructions.

Types of Chimneys¹

(b) **Masonry Chimneys.** Masonry chimneys shall be constructed to meet the requirements of Section 3702.

(c) **Metal Chimneys.** Metal chimneys shall be constructed to meet the requirements of Section 3704.

Sec. 3706. (a) Type B and B-SS-Gas Vents. Type B and B-SS gas vents shall be used only with listed gas appliances with draft hoods; but shall not be used for venting the following:

**Types and Use of
Venting Systems²**

1. Incinerators.
2. Appliances which may be converted readily to the use of solid or liquid fuels.
3. Combination gas-oil burning appliances.
4. Appliances listed for use with chimneys only.

(b) **Type BW Gas Vents.** Type BW vents shall be used only with vented recessed gas wall furnaces listed for use with such vents.

(c) **Type L Venting System.** Type L venting systems shall be used only with appliances listed as suitable for such use and gas appliances suitable for use with vents.

(d) **Metal Pipe Used as a Vent.** Metal pipe vents may be used to vent gas appliances in accordance with the following:

1. The pipe shall be of sheet copper not lighter than No. 24 B. & S. gauge or of galvanized steel not lighter than No. 20 galvanized sheet gauge number.
2. Metal pipe vents shall be used only for runs directly from the space in which the appliance is located through the roof or exterior wall to the outer air.

¹See Chimney Selection Chart, Table No. 37-B.

²See Venting Systems Selection Chart, Table No. 37-C.

TABLE NO. 37-B—CHIMNEY SELECTION CHART—TYPES OF APPLIANCES TO BE USED WITH EACH TYPE CHIMNEY
(See Table No. 37-C for Gas Appliances)

COLUMN I CHIMNEYS FOR RESIDENTIAL APPLIANCES	COLUMN II CHIMNEYS FOR LOW HEAT APPLIANCES	COLUMN III CHIMNEYS FOR MEDIUM HEAT APPLIANCES	COLUMN IV CHIMNEYS FOR HIGH HEAT APPLIANCES
1. Factory Built (residential) 2. Masonry (residential)	1. Factory Built (low heat) 2. Masonry (low heat type) 3. Metal (smokestack)	1. Factory Built (medium heat) 2. Masonry (medium heat industrial type) 3. Metal (smokestack)	1. Masonry (high heat type) 2. Metal (smokestack)
Appliances such as: 1. Ranges 2. Warm-air furnaces 3. Water heaters 4. Hot water boilers 5. Low pressure steam boilers (Not over 15 p.s.i.g.) 6. Domestic incinerators 7. Fireplaces 8. Unit heaters 9. Floor furnaces 10. Recessed heaters 11. Room heating stoves	All appliances shown in Column I. Heating equipment other than residential. Appliances such as: 1. Annealing baths 2. Bakery ovens 3. Boiling vats, for fibre 4. Candy and cruller furnaces 5. Coffee roasting ovens 6. Core ovens 7. Feed and fertilizer drying ovens 8. Forges (solid fuel) 9. Gypsum kilns 10. Hardening furnaces 11. Hot air engine furnaces 12. Nickel plate driers 13. Rosin melting furnaces 14. Steam boilers operating at not over 50 p.s.i.g. 15. Sulphur furnaces 16. Type and lead furnaces 17. Wood kilns and impregnators	Columns I and II, and appliances such as: 1. Alabaster gypsum kilns 2. Annealing furnaces 3. Charcoal furnaces 4. Cold stirring furnaces 5. Feed, fertilizer and pulp driers 6. Galvanizing furnaces 7. Gas producers 8. Hardening furnaces 9. Lehrs and glory holes 10. Lime kilns 11. Linseed oil boiling furnaces 12. Porcelain biscuit kilns 13. Steam boilers operating at over 50 p.s.i.g. 14. Water-glass kilns 15. Wood distilling furnaces 16. Wood-gas retorts	Columns I, II and III, and appliances such as: 1. Bessemer retorts and cupolas 2. Billet and bloom furnaces 3. Blast furnaces and open hearths 4. Bone calcining furnaces 5. Brass furnaces 6. Carbon point furnaces 7. Cement brick, tile and ceramic kilns 8. Coal and water gas retorts 9. Earthenware kilns 10. Glass furnaces and kilns 11. Ore roasting furnaces 12. Porcelain kilns 13. Pot-arches 14. Puddling furnaces 15. Regenerative furnaces 16. Reverberatory furnaces 17. Stacks, carburetor or super-heating furnaces 18. Vitreous enameling ovens 19. Wood carbonizing furnaces

TABLE NO. 37-C—VENTING SYSTEM SELECTION CHART
(Type of Venting System)

COLUMN I TYPE B, AND TYPE B-SS GAS Round or Oval	COLUMN II TYPE BW GAS	COLUMN III TYPE L	COLUMN IV METAL PIPE
All listed gas appliances with draft hoods such as: 1. Central furnaces 2. Floor furnaces 3. Heating boilers 4. Ranges and ovens 5. Recessed wall furnaces (above wall section) 6. Room and unit heaters 7. Water heaters	1. Recessed wall furnaces	1. Low temperature flue gas appliances listed for use with Type L venting systems 2. Gas appliances shown in Column I	1. Exterior domestic incinerator installations only 2. Residential and low-heat appliances

**Types and Use of
Venting Systems
(Continued)**

3. Metal pipe vents shall not originate in any unoccupied attic or concealed space and shall not pass through any attic, inside wall, concealed space nor through any floor or ceiling. No such vent shall extend more than three feet (3') above the roof through which it passes.

4. Metal pipe vents shall not be used outside in cold climates unless they are adequately insulated.

**Installation
Requirements
for Vents**

Sec. 3707. (a) Termination. Each vent shall extend above the roof surface and through its flashing and shall terminate in an approved cap with a venting capacity not less than that of the vent. The outlet opening of any such vent shall be not less than twelve inches (12") from any portion of the building, nor less than four feet (4') from any of that portion of the building or structure which extends at an angle of more than 45 degrees upward from the horizontal. No such vent outlet shall terminate less than four feet (4') from or one foot (1') above any door, window or air intake.

No gravity operated vents shall terminate less than five feet (5') in vertical height above the vent collar of the appliance.

Power exhauster operated vents in commercial and industrial buildings need not comply with the above termination requirements provided:

1. Approval is obtained from the Building Official;
2. The vent terminates at an elevation at least ten feet (10') above ground level and at least two feet (2') from building and roof surfaces;
3. The vent meets the other requirements of Sections 3707 and 3708.

Vents for gas appliances shall terminate at an elevation not less than five feet (5') above the highest connected appliance draft hood outlet.

A Type BW gas vent or combination of Type BW and Type B shall terminate at an elevation not less than twelve feet (12') above the bottom of the wall furnace.

(b) **Clearance.** All vents shall be installed with clearances to combustibles as specified in this Section, or in accordance with individual listings.

Single wall metal pipe may be used as a gas vent only provided it is installed with minimum clearances from combustible materials as follows:

1. Appliances without draft hoods, eighteen inches (18").
2. Unlisted appliances equipped with draft hoods, nine inches (9").
3. Boilers and furnaces equipped with listed conversion burners and draft hoods, nine inches (9").
4. Listed appliances with draft hoods, except incinerators, six inches (6").

Where a metal pipe vent passes through an exterior wall constructed of combustible material, except as provided in Subsection (d) below, it shall be guarded at the point of passage by a ventilating metal thimble not smaller than the following:

**Installation
Requirements
for Vents
(Continued)**

1. For listed gas-burning appliances with draft hoods, except incinerators, four inches (4") larger in diameter than the vent pipe, unless there is a run of not less than six feet (6') of vent pipe in the open, between the draft hood outlet and the thimble, in which case the thimble may be two inches (2") larger in diameter than the vent pipe.

2. For unlisted gas-burning appliances with draft hoods, six inches (6") larger in diameter than the vent pipe.

3. For incinerators and appliances without draft hoods, twelve inches (12") larger in diameter than the vent pipe.

4. In lieu of thimble protection, all combustible material in the wall shall be cut away from the vent pipe a sufficient distance to provide the clearances specified in this Subsection and any material used to close up such opening shall be entirely incombustible.

Metal pipe vent passing through a roof constructed of combustible material shall be guarded at the point of passage as specified for exterior wall by Subsection (h) 2 above, or by metal thimbles not less than four inches (4") larger in diameter than the pipe with the annular space filled with mineral wool or other approved incombustible insulating material.

Clearances with Type BSS vents used with unlisted gas appliances shall be as follows:

With draft hood six inches (6");

Without draft hood nine inches (9");

As a chimney connector for solid or liquid fuel appliances twelve inches (12").

(c) **Protection.** Suitable provisions shall be made to prevent mechanical injury to Type B vents where they extend through walls, floors or roofs.

(d) **Support.** All portions of gas vents and chimneys shall be adequately supported for the weight and design. Listed gas vents and factory-built chimneys shall be supported and spaced in accordance with their listings and the manufacturer's instructions.

(e) **Size.** Every gravity vent shall be of a size not less than the draft hood collar on the appliance attached thereto. In no case shall the area be less than the area of three-inch (3") diameter pipe. When more than one appliance vents into a vent, the vent area shall be not less than the area of the largest vent connector plus 50 per cent of the areas of the additional vent connectors. An oval vent may be used provided its area is not less than the area of the round pipe for which it is substituted. The minimum interior dimension shall be not less than two inches (2").

**Installation
Requirements
for Vents
(Continued)**

EXCEPTION: The size of gravity vents and their connectors shall not govern where engineering methods approved by the Building Official have been used to design the venting system.

(f) **Vent Offsets.** Any vent may have not more than two offsets of not more than 45 degrees from the vertical provided that if such offset is more than three feet (3') in length it shall be supported for the weight and design to maintain proper clearances, to prevent physical damage and to prevent separation of the joints.

If absolutely necessary, a vent may have one offset of not more than 60 degrees from the vertical, and if more than three feet (3') in length, shall be supported for the weight and design to maintain proper clearances, to prevent physical damage, and to prevent separation of the joints.

Any angle greater than 45 degrees from the vertical is considered horizontal. The total horizontal run of a vent, plus the horizontal vent connection, shall not be greater than 75 per cent of the vertical height of the vent. In no case shall the total horizontal be greater than fifteen feet (15') in over-all length.

**Chimney
Connectors and
Vent Connectors**

Sec. 3708. (a) Materials. Chimney connectors shall be of substantial metal construction of not less than the following gauge:

GALVANIZED SHEET GAUGE NO.	DIAMETER OF CONNECTOR
24	Less than 10"
22	10" to 12"
20	14" to 16"
16	Over 16"

Vent connectors serving listed appliances with draft hoods may be constructed of Type B, Type B-SS or when the former are not required, of single wall metal provided they meet the limitations of use specified in this Chapter. Type B-SS material may be used as connectors for gas-fired appliances without draft hoods and oil-fired appliances.

Vent connectors, constructed of single wall metal, serving gas appliances shall be not less than that of No. 26 manufacturer's standard gauge.

(b) **Installation. 1. Interconnections.** Two or more vent or chimney connectors shall not be joined unless the common connector, the manifold and the vent or chimney are properly sized to serve the appliances connected thereto and adequate draft is available to remove all products of combustion to the outdoors. Gas and oil appliances, so connected, shall be equipped with primary safety controls.

Connectors serving gravity vent type appliances shall not be connected to a chimney, vent or venting system served by

a power exhaustor unless the connection is made on the negative pressure side of the power exhaustor.

2. **Clearance.** Single wall metal connectors shall be installed with clearance to combustibles as shown in Table No. 37-D.

3. **Size.** The connector for its entire length shall be not smaller than the flue collar of the appliance unless otherwise recommended by the appliance, chimney or vent manufacturer.

4. **Location.** When the connector used for a gas appliance having a draft hood is located in or passes through a crawl space or other cold area that portion of the connector shall be of listed Type B or Type B-SS vent material or provided with equal means of insulation.

5. **Length.** All connectors shall be as short and straight as possible. An appliance shall be located as close as practicable to the chimney, gas vent or venting system. The connector shall be not longer than 75 per cent of the portion of the chimney or vent above the inlet connection unless a part of an engineered venting system.

**Chimney
Connectors and
Vent Connectors,
(Continued)**

TABLE NO. 37-D—CONNECTOR CLEARANCES

DESCRIPTION OF APPLIANCE	MINIMUM CLEARANCES (Inches) ¹
RESIDENTIAL APPLIANCES	
Column I (Table No. 37-B)	
Gas appliances without draft hoods.....	18
Electric, gas and oil incinerators.....	18
Oil and solid-fuel appliances.....	18
Unlisted gas appliance with draft hoods.....	9
Boilers and furnaces equipped with listed burner and with draft hood.....	9
Column I (Table No. 37-C)	
Listed gas appliances with draft hoods except in- cinerators ²	6
COMMERCIAL-INDUSTRIAL APPLIANCES	
Low-heat Appliances, Column II (Table No. 37-B)	
Gas, oil, and solid-fuel boilers, furnaces and water heaters.....	18
Ranges, restaurant type.....	18
Oil unit heaters.....	18
Unlisted gas unit heaters.....	18
Listed gas unit heaters with draft hoods.....	6
Other low-heat industrial appliances.....	18
Medium-heat Appliances, Column III (Table No. 37-B)	
All gas, oil, and solid-fuel appliances.....	36

¹These clearances apply except if the listing of an appliance specifies different clearances in which case the listed clearance takes precedent.

²If listed Type B, Type B-SS or Type L vent material is used, the clearance may be in accordance with the vent-material listing.

The clearances from connectors to combustible material may be reduced if the combustible material is protected in accordance with Table No. 51-B.

**Chimney
Connectors and
Vent Connectors
(Continued)**

6. **Passage through walls.** Connectors for listed gas appliances with draft hoods other than incinerators may pass through walls or partitions constructed of combustible material if made of listed Type B, Type B-SS or Type L material and installed with not less than listed clearances to combustible material. Connectors shall be exposed to view throughout their length.

Connectors serving low-, medium- or high-heat appliances as classified in Table No. 37-B shall not pass through walls or partitions but shall be located in the same space as the appliance and in full view throughout their entire length.

7. **Resistance.** Connectors shall be installed so as to avoid sharp turns or other construction features which would create excessive resistance to the flow of combustion gases. No device which will obstruct the free flow of combustion gases shall be installed in a connector, chimney or vent. This shall not be construed to prohibit the use of devices specifically listed for installation in a connector such as draft regulators and safety controls.

8. **Joints.** Chimney and vent connectors shall be securely supported and joints fastened with sheet metal screws, rivets, or other approved means.

9. **Connection.** A connector to a masonry chimney shall extend through the wall to the inner face of liner but not beyond, and shall be firmly cemented to masonry. A thimble may be used to facilitate removal of the connector for cleaning, in which case the thimble shall be permanently cemented in place with high-temperature cement.

No connector shall pass through any floor or ceiling.

No chimney or vent shall have connector openings in more than one story of a building, unless provision is made for effectively closing such openings with devices made of incombustible materials whenever their use is discontinued temporarily, and completely closing the opening.

10. **Fireplace.** A connector shall not be connected to a chimney serving a fireplace unless the fireplace opening or the chimney which vents the fireplace is permanently sealed below the connection.

11. **Dampers.** Manually operated dampers shall not be placed in chimneys, vents or chimney or vent connectors of liquid- or gas-burning appliances. Fixed baffles on the appliance side of draft hoods and draft regulators shall not be classified as dampers.

Automatically operated dampers shall be of approved type designed to maintain a safe damper opening at all times and arranged to prevent firing of the burner unless the damper is opened to a safe position.

12. **Draft regulators.** A draft regulator shall be installed in the connector serving a liquid fuel-burning appliance unless the appliance is approved for use without one.

A draft regulator may be installed in the connector serving a listed gas incinerator when recommended by the incinerator manufacturer. Such draft regulators shall be installed in accordance with the installation instructions accompanying the incinerator.

A draft regulator furnished as part of a listed gas appliance shall be installed in the connector serving the appliance.

A draft regulator when used shall be installed in the same room or enclosure as the appliance in such a manner that no difference in pressure between air in the vicinity of the regulator and the combustion air supply will be permitted.

13. **Pitch.** Chimney or vent connectors shall have a rise of not less than one-half inch ($\frac{1}{2}$ ") to the foot.

14. **Support.** Vent connectors shall be securely supported for the weight and design to maintain proper clearances, to prevent physical damage, and to prevent separation of the joints.

Sec. 3709. Listed appliances having sealed combustion chambers and which are so constructed and installed that all air for combustion is derived from outside the building and all flue gases are discharged to the outside atmosphere shall be considered as properly vented when installed in accordance with their listing and manufacturer's instructions. Venting requirements as set forth in this Chapter shall not apply.

Sec. 3710. (a) General. Restaurant-type ranges, fry kettles, candy kettles, cruller furnaces and appliances for the frying of bakery or confectionery products, shall be provided with ventilating hoods and ducts to the outside air to take off the smoke, gases and vapors, unless such appliances are of the enclosed type and are vented in an approved manner.

Ventilating hoods and exhaust systems shall be so designed that cooking vapors and residues will not be discharged into the kitchen area.

(b) **Automatically Operated Appliances.** When automatically operated appliances, such as water heaters, are vented through natural draft ventilating hoods, dampers shall not be installed in the ventilating system. When the ventilating hood or exhaust system is equipped with power means of exhaust, the appliance control system shall be so interlocked as to permit appliance operation only when the power means of exhaust is in operation.

(c) **Location.** Such hoods shall be raised not more than seven feet (7') above the floor. Hoods shall be of sufficient depth to extend at least six inches (6") beyond all sides of units served.

**Chimney
Connectors and
Vent Connectors
(Continued)**

**Special Venting
Arrangements**

**Ventilating Hoods
and Exhaust
Systems**

**Ventilating Hoods
and Exhaust
Systems
(Continued)**

(d) **Construction.** All hoods and their ducts shall be constructed of incombustible materials with tight, unsoldered joints. Metal hoods shall be not less than No. 22 B. & S. gauge copper or No. 24 U. S. gauge galvanized steel, and metal hood ducts shall be not less than No. 18 U. S. gauge, or No. 20 U. S. gauge stainless steel, and shall not be connected with any other ventilating system. The hood shall have a grease trough extending around the perimeter draining into a grease container outside the hood. Cleanout openings in the fire-resistive shaft and hood duct shall be provided where the duct makes any abrupt change in direction.

Handholes, for inspection and cleaning purposes, equipped with tight-fitting sliding or swinging doors and latches shall be provided in horizontal sections of exhaust ducts. Such openings should be at the sides of the horizontal run in order to prevent dripping of residue. Spacing of such openings shall not exceed twenty feet (20'). Openings shall have a minimum dimension of six inches (6").

(e) **Grease Filters.** Approved grease filters or grease baffles shall be installed at the inlet of the exhaust system.

(f) **Air Velocity.** Exhaust duct systems shall be so designed as to create a conveying air velocity of not less than fifteen hundred feet (1500') and not more than twenty-two hundred feet (2200') per minute and that a minimum velocity of fifty feet (50') per minute be maintained across the net cross-sectional area of the hood assembly face openings.

(g) **Clearance to Combustible Material.** Such hoods and their ducts shall be installed to provide a clearance to woodwork or other combustible material, whether plastered or unplastered, of not less than eighteen inches (18"). This clearance may be reduced to the minimum requirements set forth in Table No. 51-B.

(h) **Duct Enclosure.** Unless listed ducts are used, ducts penetrating a ceiling or floor shall be enclosed in a fire-resistive shaft covered on one side as required for one-hour fire-resistive construction with no combustible materials used inside fire protection and the shaft shall be separated from the duct by a minimum three-inch (3") air space vented to the outside air. Ducts with a horizontal run shall have a minimum pitch at any point of one-fourth inch ($\frac{1}{4}$ ") per foot toward the hood.

**Fireplaces and
Barbecues**

Sec. 3711. (a) General. Fireplaces, barbecues, smoke chambers and fireplace chimneys shall be of solid masonry or reinforced concrete and shall conform to the minimum requirements set forth in this Section. Factory built metal room heating stoves may be used in accordance with their approvals and if approved by the Building Official.

(b) **Fireplace Walls.** Structural walls of fireplaces shall be not less than eight inches (8") in thickness. Firebox walls shall

**Fireplaces and
Barbecues
(Continued)**

be not less than eight inches (8") in thickness. The firebox shall be not less than twenty inches (20") in depth and shall be lined with four inches (4") of firebrick. The maximum thickness of joints in firebrick shall be one-fourth inch ($\frac{1}{4}$ ").

(c) **Hoods.** Metal hoods used as a part of a fireplace or barbecue shall be not less than No. 18 gauge copper, galvanized steel, or other equivalent corrosion-resistant ferrous metal with all seams and connections of smokeproof unsoldered construction. The hoods shall be sloped at an angle of 45 degrees or less from the vertical and shall extend horizontally at least six inches (6") beyond the limits of the firebox. Metal hoods shall be kept a minimum of eighteen inches (18") from combustible materials unless approved for reduced clearances.

(d) **Metal Heat Circulators.** Approved metal heat circulators may be installed in fireplaces.

(e) **Smoke Chamber.** Front and side walls shall be not less than eight inches (8") in thickness. Smoke chamber back walls shall be not less than six inches (6") in thickness.

(f) **Fireplace Chimneys.** Walls of chimneys without flue lining shall be not less than eight inches (8") in thickness. Walls of chimneys with flue lining shall be not less than four inches (4") in thickness and shall be constructed in accordance with Section 3702 (d) 1.

Where grouted masonry is used in fireplaces and their chimneys, grout shall be Type S mortar or fine grout. See Section 3702 (e) for flue lining and Section 2403 (r) and Section 2403 (s) for mortar and grout.

Where necessary, such chimneys may be corbeled at a slope of not more than four inches (4") in twenty-four inches (24") but not more than one-third the dimension of the chimney in the direction of the corbeling. Where lined, the lining shall be accurately cut to fit.

(g) **Clearance to Combustible Material.** Combustible material shall not be placed within two inches (2") of fireplace, smoke chamber, or chimney walls when built entirely within a structure, or within one inch (1") when the chimney is built entirely outside the structure. In lieu of one-inch (1") clearance between chimney and exterior wall, one-half-inch ($\frac{1}{2}$ ") gypsum board may be substituted. Combustible materials shall not be placed within six inches (6") of the fireplace opening. No such combustible material within twelve inches (12") of the fireplace opening shall project more than one-eighth inch ($\frac{1}{8}$ ") for each one-inch (1") clearance from such opening.

No part of metal hoods used as part of a fireplace, barbecue or heating stove shall be less than eighteen inches (18") from combustible material. This clearance may be reduced to the minimum requirements set forth in Table No. 51-B.

**Fireplaces and
Barbecues
(Continued)**

(h) **Areas of Flues, Throats and Dampers.** The net cross-sectional area of the flue and of the throat between the firebox and the smoke chamber of a fireplace shall be not less than as set forth in Table No. 37-A. Where dampers are used, they shall be of not less than No. 12 gauge metal. When fully opened, damper openings shall be not less than 90 per cent of the required flue area. When fully opened, damper blade shall not extend beyond the line of the inner face of the flue.

(i) **Lintel.** Masonry over the fireplace opening shall be supported by an incombustible lintel.

(j) **Hearth.** Every fireplace shall be provided with a brick, concrete, stone or other approved incombustible hearth slab at least twelve inches (12") wider on each side than the fireplace opening and projecting at least eighteen inches (18") therefrom. This slab shall be not less than four inches (4") thick and shall be supported by incombustible materials or reinforced to carry its own weight and all imposed loads. Combustible forms and centering shall be removed.

(k) **Firestopping.** Firestopping between chimneys and wooden construction shall meet the requirements specified in Section 2508.

(l) **Nonconforming Fireplaces.** Imitation and other fireplaces not conforming to the other requirements of this Section shall not exceed six inches (6") in depth. Gas-burning appliances may be installed in such nonconforming fireplaces provided that compliance is made in accordance with the requirements of this Chapter on flues or vents and clearances from combustible materials in Chapter 51, Appendix.

(m) **Support.** Fireplaces shall be supported on foundations designed as specified in Chapters 23, 24 and 28.

CHAPTER 38—FIRE-EXTINGUISHING SYSTEMS

Sec. 3801. Standard automatic fire-extinguishing systems shall be installed as specified in this Chapter in the following places:

1. In every story, basement or cellar of a building when the floor area exceeds fifteen hundred square feet (1500 sq. ft.) and there is not provided at least twenty square feet (20 sq. ft.) of opening entirely above grade in each fifty lineal feet (50 lin. ft.) or fraction thereof of exterior wall in the story or basement or cellar on at least one side of the building. Openings shall have a minimum dimension of not less than thirty inches (30").

When openings in a story, basement, or cellar are provided on only one side and the opposite wall of such story, basement, or cellar is more than seventy-five feet (75') from such openings, the story, basement, or cellar shall be provided with an approved automatic fire-extinguishing system or openings as specified above shall be provided on at least two sides of the exterior walls of the story, basement, or cellar.

If any portion of a basement or cellar is located more than seventy-five feet (75') from openings required in this Section, the basement or cellar shall be provided with an approved automatic fire-extinguishing system.

2. In cellars in Groups A, B and C Occupancies and in all usable space below a cellar or basement.

3. In the following locations in Group A Occupancies and Divisions 1 and 2, Group B Occupancies having a stage or enclosed platform:

- A. In all dressing room sections, workshops, and storerooms.
- B. Where there is a stage; under the gridiron, stage floor, tie and fly galleries, and in all places back of the proscenium wall.
- C. Over enclosed platforms having an area of more than one thousand square feet (1000 sq. ft.) and over any usable space under such platforms.

4. In any enclosed occupied space in Groups B, C, and D Occupancies below or over a stairway, except where the entire construction is as required for Type I or II buildings, and in all portions of basements or cellars used for storage or maintenance work rooms.

5. In Divisions 1 and 2, Group E Occupancies having an area of more than fifteen hundred square feet (1500 sq. ft.); in Division 3, Group E Occupancies having an area of more than three thousand square feet (3000 sq. ft.); and in Division 4, Group E Occupancies more than one story in height.

Sec. 3802. Required automatic fire-extinguishing systems shall comply in all respects with the regulations set forth in U.B.C. Standard No. 38-1-64 or No. 38-2-64.

**Automatic
Fire-
Extinguishing
Systems:
Where
Required**

**Detailed
Requirements**

**Detailed
Requirements
(Continued)**

EXCEPTIONS: 1. A single water supply equal to the primary supply required by such regulations may be accepted as complying with the requirements of this Code.

2. Automatic fire-extinguishing systems required in paragraph 4, Section 3801, may be supplied from the domestic water system and need not comply with the provisions of this Section except as to pipe sizes and spacing of heads, provided that where the domestic water supply has a pressure less than 15 pounds per square inch, an approved automatic chemical extinguisher may be used in lieu of the automatic fire-extinguishing system.

3. The alarm valve required for a standard automatic fire-extinguishing system shall not be required in the cellars of Groups B, C, D, E, F, G, and H Occupancies where the area of such cellar is less than three thousand square feet (3000 sq. ft.).

**Dry
Standpipes**

Sec. 3803. Every building four or more stories in height shall be equipped with one or more dry standpipes.

**Dry
Standpipes:
Detailed
Requirements**

Sec. 3804. (a) Construction. Dry standpipes shall be of wrought iron or galvanized steel and together with fittings and connections shall be of sufficient strength to withstand 300 pounds of water pressure to the square inch when ready for service, without leaking at the joints, valves, or fittings.

Tests shall be conducted by the owner or contractor in the presence of a representative of the Fire Department whenever deemed necessary and ordered by the Building Official. The tests shall be applied at the top and bottom connections of such standpipes and the owner or contractor shall be responsible for any damage caused by breakage or faulty installation while such tests are being conducted. After such standpipes have been tested, the owner or contractor shall remove all water therefrom.

(b) **Size.** Dry standpipes shall be of such a size as to be capable of delivering 250 gallons per minute from each of any three outlets simultaneously under the pressure created by one fire engine or pumper, based on the existing city equipment available. No part of a dry standpipe system other than hose connections shall be less than three inches (3") in diameter.

(c) **Number Required.** Every building four or more stories in height where the area of any floor above the third floor is ten thousand square feet (10,000 sq. ft.) or less shall be equipped with not less than one dry standpipe and an additional standpipe shall be installed for each additional ten thousand square feet (10,000 sq. ft.) or fraction thereof.

(d) **Location.** Standpipes shall be located within stairway enclosures or as near such stairways as possible or shall be on the outside of, embedded within, or immediately inside of an exterior wall and within one foot (1') of an opening in

a stairway enclosure or the balcony or vestibule of a smoke-proof tower or an outside exit stairway.

(c) **Siamese Connections.** All four-inch (4") dry standpipes shall be equipped with a two-way Siamese fire department connection. All five-inch (5") dry standpipes shall be equipped with a three-way Siamese fire department connection and all six-inch (6") dry standpipes shall be equipped with a four-way Siamese fire department connection. All Siamese inlet connections shall be located on a street front of the building and not less than one foot (1') nor more than four feet (4') above the grade and shall be equipped with clapper-checks and substantial plugs. All Siamese inlet connections shall be recessed in the wall or otherwise substantially protected.

(f) **Outlets.** All dry standpipes shall extend from the ground floor to and over the roof and shall be equipped with a two and one-half-inch (2½") outlet not more than four feet (4') above the floor level at each story. All dry standpipes shall be equipped with a two-way two and one-half-inch (2½") outlet above the roof. All outlets shall be equipped with gate valves with substantial chains.

(g) **Threads.** All hose threads in connection with such standpipe installations shall be uniform with that used by the local fire department.

(h) **Signs.** An iron or bronze sign with raised letters at least one inch (1") high shall be rigidly attached to the building adjacent to all Siamese connections and such sign shall read: "CONNECTION TO DRY STANDPIPE."

Sec. 3805. Every Group A and B Occupancy of any height, and every Group C Occupancy two or more stories in height, and every Group D, E, F, G, and H Occupancy three or more stories in height and every Group E and F Occupancy over twenty thousand square feet (20,000 sq. ft.) in area shall be equipped with one or more interior wet standpipes extending from the cellar or basement into the topmost story, provided that Group B buildings having no stage and having a seating capacity of less than 500 need not be equipped with interior standpipes.

Sec. 3806. (a) Construction. Interior wet standpipes shall be constructed as required for dry standpipes.

(b) **Size.** Interior wet standpipes shall have an internal diameter sufficient to deliver 50 gallons of water per minute under 30 pounds per square inch pressure at the hose connection, based on the available water supply. Buildings of Groups A and B Occupancies shall have wet standpipe systems capable of delivering the required quantity and pressure from any two outlets simultaneously; for all other occupancies only one outlet need be figured to be open at one time. In no case shall the internal diameter of a wet standpipe be less

**Dry
Standpipes:
Detailed
Requirements
(Continued)**

**Wet
Standpipes:
Where
Required**

**Wet
Standpipes:
Detailed
Requirements**

**Wet
Standpipes:
Detailed
Requirements
(Continued)**

than two inches (2"), except when the standpipe is attached to an automatic fire-extinguishing system as set forth in U.B.C. Standard No. 38-1-64.

Any approved formula which determines pipe sizes on a pressure drop basis may be used to determine pipe sizes for wet standpipe systems. The Building Official may require delivery and pressure tests on completed wet standpipe systems before approving such systems.

(c) **Number Required.** Wet standpipes shall be so located that any portion of the building can be reached therefrom with a hose not exceeding seventy-five feet (75') in length.

(d) **Location.** In Groups A and B Occupancies, outlets shall be located as follows:

On each side of the stage, on each side of the rear of the auditorium, and on each side of the rear of the balconies. Where occupant loads are less than 500 the number of locations noted above may be reduced upon the approval of the Building Official. In Groups C, D, E, F, G, and H Occupancies the location of all interior wet standpipes shall be approved by the Building Official.

(e) **Outlets.** All interior wet standpipes shall be equipped with a one and one-half-inch (1½") valve in each story, including the basement or cellar of the building, and located not less than one foot (1') nor more than six feet (6') above the floor.

(f) **Threads.** All hose threads in connection with the installation of such standpipes, including valves and reducing fittings, shall be uniform with that used by the local fire department.

(g) **Water Supplies.** All interior wet standpipes shall be connected to a street water main not less than four inches (4") in diameter, or when the water pressure is insufficient to maintain 30 pounds pressure at the highest hose outlet such standpipe shall be connected to a pressure tank, gravity tank, or fire pump. Such supply shall be sufficient to furnish at least 30 pounds pressure at the topmost standpipe outlet.

When more than one interior wet standpipe is required in the building, such standpipes shall be connected at their bases or at their tops by pipes of equal size.

(h) **Pressure and Gravity Tanks.** Tanks shall have a capacity sufficient to furnish at least 250 gallons per minute for a period of not less than 10 minutes. Such tanks shall be located so as to provide not less than 25 pounds pressure at the topmost hose outlet for its entire supply. Discharge pipes from pressure tanks shall extend two inches (2") into and above the bottom of such tanks. All tanks shall be equipped with a manhole, ladder and platform, drainpipe, water and pressure gauges. Every pressure tank shall be tested in place after installation and proved tight at a hydrostatic pressure 50 per cent in excess of the working pressure

required. Where such tanks are used for domestic purposes the supply pipe for such purposes shall be located at or above the center line of such tanks. Incombustible supports shall be provided for all such supply tanks and not less than a three-foot (3') clearance shall be maintained over the top and under the bottom of all pressure tanks.

(i) **Fire Pumps.** Fire pumps shall have a capacity of not less than 250 gallons per minute with a pressure of not less than 25 pounds at the topmost hose outlet. The source of supply for such pump shall be a street water main of not less than four-inch (4") diameter or a well or cistern containing a one-hour supply. Such pumps shall be supplied with an adequate source of power and shall be automatic in operation.

(j) **Hose and Hose Reels.** Each hose outlet of all interior wet standpipes shall be supplied with a hose not less than one and one-half inches (1½") in diameter. Such hose shall be equipped with a suitable brass or bronze nozzle and shall be not over seventy-five feet (75') in length. An approved standard form of wall hose reel or rack shall be provided for the hose and shall be located so as to make the hose readily accessible at all times and shall be recessed in the walls or protected by suitable cabinets.

Sec. 3807. Basement pipe inlets shall be installed in the first floor of every store, warehouse, or factory where there are cellars or basements under same, except where in such cellars or basements there is installed a fire-extinguishing system as specified by this Code, or where the cellars or basements are used for banking purposes, safe deposit vaults, or similar uses.

All basement pipe inlets shall be of cast iron, steel, brass, or bronze with lids of cast brass or bronze and shall consist of a sleeve not less than eight inches (8") in diameter through the floor extending to and flush with the ceiling below and with a top flange, recessed with an inside shoulder, to receive the lid and flush with the finish floor surface. The lid shall be a solid casting and have a ring lift recessed in the top thereof, so as to be flush. The lid shall have the words "FIRE DEPARTMENT ONLY, DO NOT COVER UP," cast in the top thereof. The lid shall be installed in such a manner as to permit its removal readily from the inlet.

The location of such basement pipe inlets shall be approved by the Building Official and shall be kept readily accessible at all times to the Fire Department.

Sec. 3808. All fire-extinguishing systems, including automatic sprinklers, wet and dry standpipes, automatic chemical extinguishers, basement pipe inlets and the appurtenances thereto shall meet the approval of the Fire Department as to installation and location and shall be subject to such periodic tests as it may require.

**Wet
Standpipes:
Detailed
Requirements
(Continued)**

**Basement
Pipe
Inlets**

Approvals

CHAPTER 39—STAGES AND PLATFORMS

**Stage
Ventilators**

Sec. 3901. (a) General. There shall be one or more ventilators constructed of metal or other incombustible material near the center and above the highest part of any working stage raised above the stage roof and having a total ventilation area equal to at least five per cent of the floor area within the stage walls. The entire equipment shall conform to the following requirements specified in Subsections (b) to (i) of this Section, or their equivalent.

(b) Opening Action. Ventilators shall open by spring action or force of gravity sufficient to overcome the effects of neglect, rust, dirt, frost, snow, or expansion by heat or warping of the framework.

(c) Glass. Glass, if used in ventilators, must be protected against falling on the stage. A wire screen, if used under the glass, must be so placed that if clogged it cannot reduce the required ventilating area or interfere with the operating mechanism or obstruct the distribution of water from the automatic fire-extinguishing systems.

(d) Design. Ventilators, penthouses, and supporting framework shall be designed in accordance with Chapter 23.

(e) Automatic Openings. Each ventilator shall be arranged to open automatically after the outbreak of fire by the use of an approved automatic closing device as defined in Chapter 43. The fusible link and operating cable shall hold each door closed against a minimum 30-pound counterforce exerted by springs or counterweights. This minimum counterforce shall be exerted on each door through its entire arc of travel and for a minimum 115°. A manual control shall be provided.

(f) Spring Actuation. Springs, when employed to actuate ventilator doors, shall be capable of maintaining full required tension indefinitely. Springs shall not be stressed more than 50 per cent of their rated capacity and shall not be located directly in the air stream, nor exposed to the elements.

(g) Location of Fusible Links. A fusible link shall be placed in the cable control system on the underside of the ventilator at or above the roof line, or as approved by the Building Official, and shall be so located as not to be affected by the operation of fire-extinguishing systems.

(h) Control. Remote, manual or electrical control shall provide for both opening and closing of the ventilator doors for periodic testing and shall be located at a point on the stage designated by the Building Official. When remote control of ventilator is electrical, power failure shall not affect its instant operation in the event of fire. Hand winches may be employed to facilitate operation of manually controlled ventilators.

(i) **Curb Construction.** Curbs shall be constructed as required for the roof.

Sec. 3902. Gridirons, fly galleries, and pinrails shall be constructed of incombustible materials and fire protection of steel and iron may be omitted. Gridirons and fly galleries shall be designed to support not less than 75 pounds live load per square foot. **Gridirons**

Each loft block well shall be designed to support 250 pounds per lineal foot and the head block well shall be designed to support the aggregate weight of all the loft block wells served. The head block well must be provided with an adequate strongback or lateral brace to offset torque.

The main counterweight sheave beam shall be designed to support a horizontal and vertical uniformly distributed live load sufficient to accommodate the weight imposed by the total number of loft blocks in the gridiron. The sheave blocks shall be designed to accommodate the maximum load for the loft blocks or head blocks served with a safety factor of five.

Sec. 3903. In buildings having a stage, the dressing room sections, workshops, and storerooms shall be located on the stage side of the proscenium wall and shall be separated from each other and from the stage by not less than a One-Hour Fire-Resistive Occupancy Separation, as defined in Chapter 5. **Rooms Accessory to Stage**

Sec. 3904. A stage as defined in Section 420 shall be completely separated from the auditorium by a proscenium wall of not less than two-hour incombustible construction. The proscenium wall shall extend not less than four feet (4') above the roof over the auditorium. **Proscenium Walls**

Proscenium walls may have, in addition to the main proscenium opening, one opening at the orchestra pit level and not more than two openings at the stage floor level, each of which shall be not more than twenty-five square feet (25 sq. ft.) in area.

All openings in the proscenium wall of a stage shall be protected by a fire assembly having a one and one-half-hour fire-resistive rating. The proscenium opening, which shall be the main opening for viewing performances, shall be provided with a self-closing fire-resistive curtain as provided in U.B.C. Standard No. 6-1-64.

Sec. 3905. All parts of stage floors shall be of Type I construction except the part of the stage extending back from and six feet (6') beyond the full width of the proscenium opening on each side, which may be constructed of steel or heavy timbers covered with a wood floor of not less than two inches (2") nominal thickness. No part of the combustible construction except the floor finish shall be carried through the proscenium opening. All parts of the stage floor shall be designed to support not less than 125 pounds per square foot. **Stage Floors**

Openings through stage floors shall be equipped with tight-fitting trap doors of wood of not less than two inches (2") nominal thickness.

Platforms

Sec. 3906. (a) Ventilators. Enclosed platforms shall be provided with one or more ventilators conforming to the requirements of Section 3901, except that the total area shall be equal to five per cent of the area of the platform. When more than one ventilator is provided, they shall be so spaced as to provide proper exhaust ventilation.

Ventilators shall not be required for enclosed platforms having a floor area of five hundred square feet (500 sq. ft.) or less.

(b) Construction. Walls and ceiling of an enclosed platform in an assembly room shall be of not less than one-hour fire-resistive construction.

Any usable space having headroom of four feet (4') or more under a raised platform of an assembly room shall be of not less than one-hour fire-resistive construction.

(c) Accessory Rooms. In buildings having an enclosed platform, the dressing-room section, workshops, and store-rooms shall be separated from each other and from the rest of the building by not less than a One-Hour Fire-Resistive Occupancy Separation as defined in Chapter 5, except that a chair-storage area having headroom of not more than four feet (4') need not be so separated.

Stage Exits

Sec. 3907. At least one exit not less than thirty-six inches (36") wide shall be provided from each side of the stage opening directly or by means of a passageway not less than thirty-six inches (36") in width to a street or exit court. An exit stair not less than two feet six inches (2'6") wide shall be provided for egress from each fly gallery. Each tier of dressing rooms shall be provided with at least two means of egress each not less than two feet six inches (2'6") wide and all such stairs shall be constructed as specified in Chapter 33. The stairs required in this Section need not be enclosed.

Miscellaneous

Sec. 3908. A protecting hood shall be provided over the full length of the stage switchboard.

Flame-Retarding Requirements

Sec. 3909. No combustible scenery, drops, props, decorations, or other combustible effects shall be placed on any stage or enclosed platform unless it is treated with an effective fire-retardant solution and maintained in a nonflammable condition as approved by the Fire Department.

CHAPTER 40—MOTION PICTURE PROJECTION ROOMS

Sec. 4001. (a) **Scope.** The provisions of this Chapter shall apply only where ribbon type motion picture film in excess of seven-eighths-inch ($\frac{7}{8}$ ") width and electric arc projection equipment are used. **General**

(b) **Projection Room Required.** Every motion picture machine using ribbon type film in excess of seven-eighths-inch ($\frac{7}{8}$ ") width and electric arc projection equipment, together with all electrical devices, rheostats, machines, and all such films present in any Group A, B, or C Occupancy, shall be enclosed in a projection room large enough to permit the operator to walk freely on either side and back of the machine.

Sec. 4002. Every projection room shall be of not less than one-hour fire-resistive construction throughout and the walls and ceiling shall be finished with incombustible material. **Construction**

The ceiling shall be not less than eight feet (8') from the finished floor. The room shall have a floor area of not less than eighty square feet (80 sq. ft.) and forty square feet (40 sq. ft.) for each additional machine.

Sec. 4003. Every projection room shall have at least two doorways separated by not less than one-third the perimeter of the room, each at least thirty inches (30") wide and eighty inches (80") high. **Exits**

All entrances to a projection room shall be protected by a self-closing fire assembly having a three-fourths-hour fire-resistive rating. Such doors shall open outward and lead to proper exits as required in Chapter 33 and shall not be equipped with any latch. The maximum width of such door need be no more than thirty inches (30").

Sec. 4004. (a) **Types.** Ports in projection room walls shall be of three kinds: projection ports; observation ports; and combination ports used for both observation and for stereopticon, spot, or floodlight machines. **Ports and Openings**

(b) **Ports Required.** There shall be provided for each motion picture projector not more than one projection port, which shall be limited in area to one hundred and twenty square inches (120 sq. in.), and not more than one observation port, which shall be limited in area to two hundred square inches (200 sq. in.). There shall be not more than three combination ports, each of which shall not exceed thirty inches by twenty-four inches (30" x 24"). Each port opening shall be completely covered with a pane of glass.

EXCEPTION: When acetate (safety) film is used projection ports may be increased in size to an area not to exceed seven hundred and twenty square inches (720 sq. in.).

**Ports and
Openings
(Continued)**

(c) **Shutters.** Each port and every other opening in projection room walls, including any fresh-air inlets but excluding exit doors and exhaust ducts, shall be provided with a shutter of not less than No. 10 U. S. gauge sheet metal or its equivalent large enough to overlap at least one inch (1") on all sides of such opening. Shutters shall be arranged to slide without binding in guides constructed of material equal to the shutters in strength and fire resistance. Each shutter shall be equipped with a 165°F. fusible link, which when fused by heat will cause closure of the shutter by gravity. Shutters of a size greater than two hundred square inches (200 sq. in.) shall be equipped with a counterbalance. There shall also be a fusible link located over the upper magazine of each projector, which, upon operating, will close all the shutters. In addition, there shall be provided suitable means for manually closing all shutters simultaneously from any projector head and from a point within the projection room near each exit door. Shutters on openings not in use shall be kept closed.

EXCEPTION: Shutters may be omitted when acetate (safety) film only is used.

Ventilation

Sec. 4005. (a) **Inlet.** A fresh-air inlet from the exterior of the building not less than one hundred and forty-four square inches (144 sq. in.) and protected with wire netting shall be installed within two inches (2") of the floor in every projection room, the source of which shall be remote from other outside vents or flues.

(b) **Outlets.** Ventilation shall be provided by one or more mechanical exhaust systems which shall draw air from each arc lamp housing and from one or more points near the ceiling. Systems shall exhaust to outdoors either directly or through an incombustible flue used for no other purpose. Exhaust capacity shall be not less than 15 cubic feet nor more than 50 cubic feet per minute for each arc lamp plus 200 cubic feet per minute for the room itself. Systems shall be controlled from within the enclosure and have pilot lights to indicate operation. The exhaust system serving the projection room may be extended to cover rooms associated therewith such as rewind rooms. No dampers shall be installed in such exhaust systems.

Ventilation of these rooms shall not be connected in any way with ventilating or air-conditioning systems serving other portions of the building.

(c) **Exhaust Ducts.** Exhaust ducts shall be of incombustible material, and shall either be kept one inch (1") from combustible material or covered with one-half inch ($\frac{1}{2}$ ") of incombustible heat-insulating material.

**Regulation
of Equipment**

Sec. 4006. (a) **Shelves and Fixtures.** All shelves, fixtures, and fixed equipment in a projection room shall be constructed of incombustible materials.

(b) **Films.** All films not in actual use shall be stored in metal cabinets having individual compartments for reels or shall be in I.C.C. shipping containers. Metal used in the construction of cabinets shall be not less than No. 18 U. S. Standard gauge. No solder shall be used in the construction of such metal cabinets.

**Regulation
of Equipment
(Continued)**

Sec. 4007. Every projection room shall be provided with an unenclosed water closet and lavatory.

**Sanitary
Requirements**

PART VIII

FIRE-RESISTIVE STANDARDS FOR FIRE PROTECTION

CHAPTER 42—INTERIOR WALL AND CEILING FINISH

General

Sec. 4201. Interior wall and ceiling finish shall mean interior wainscoting, paneling, or other finish applied structurally or for decoration, acoustical correction, surface insulation, or similar purposes. Requirements for finishes shall not apply to trim, doors and windows or their frames, nor to materials which are less than one twenty-eighth inch (0.036") in thickness cemented to the surface of walls or ceilings, if these materials have flame-spread characteristics no greater than paper of this thickness cemented to an incombustible backing.

**Testing and
Classification
of Materials**

Sec. 4202. (a) Testing. Tests shall be made by an approved testing agency to establish flame-spread characteristics and to show that materials when cemented or otherwise fastened in place will not readily become detached when subjected to room temperatures of 300°F. for 25 minutes. Flame-spread characteristics shall be determined by one of the following methods:

1. The "Tunnel Test" as set forth in U.B.C. Standard No. 42-1-64.

2. Any other recognized method of test procedure for determining the flame-spread characteristics of finish materials that will give comparable results to those specified in Subsections 1 and 2 of this Section.

(b) Classification. The classes of materials based upon their flame-spread characteristics under the Tunnel Test shall be as set forth in Table No. 42-A. The smoke density shall be no greater than that obtained from the burning of untreated wood under similar conditions when tested in accordance with U.B.C. Standard No. 42-1-64 in the way intended for use. The products of combustion shall be no more toxic than the burning of untreated wood under similar conditions.

**Application
of Controlled
Interior
Finish**

Sec. 4203. Interior finish materials applied to walls and ceilings shall be tested as specified in Section 4202 and regulated for purposes of limiting flame-spread by the following provisions:

1. When walls and ceilings are required by any provision in this Code to be of fire-resistive or incombustible construction, the finish material of any class shall be applied directly against such fire-resistive construction or to furring strips not exceeding one and three-fourths inches (1¾") applied directly against such surfaces. The intervening spaces between such furring strips shall be filled with inorganic or Class I

material or shall be firestopped not to exceed eight feet (8') in any direction.

2. Where walls and ceilings are required to be of fire-resistive or incombustible construction and walls are set out or ceilings are dropped distances greater than specified in paragraph 1 of this Section, Class I finish materials shall be used except where the finish materials are protected on both sides by automatic fire-extinguishing systems or are attached to an incombustible backing or to furring strips installed as specified in paragraph 1. The hangers and assembly members of such dropped ceilings that are below the main ceiling line shall be of incombustible materials except that in Types III and IV construction fire-retardant treated wood may be used. The construction of each set-out wall shall be of fire-resistive construction as required elsewhere in this Code. See Section 2508 for firestopping.

3. Wall and ceiling finish materials of all classes as permitted in this Chapter may be installed directly against the wood decking or planking of Heavy-Timber Construction or to wood furring strips applied directly to the wood decking or planking installed and firestopped as specified in paragraph 1.

**Application
of Controlled
Interior Finish
(Continued)**

TABLE NO. 42-A—FLAME-SPREAD CLASSIFICATION

MATERIAL QUALIFIED BY:	
Class	Tunnel Test
I	0- 25
II	26- 75
III	76-225

TABLE NO. 42-B—MINIMUM INTERIOR-FINISH CLASSIFICATIONS

OCCUPANCY GROUP	ENCLOSED VERTICAL EXITWAYS	OTHER EXITWAYS	ROOMS OR AREAS
A	I	II	III
B	I	II	III
C	I	II	III
D	I	II	II ¹
E	I	II	III ²
F	I	II	III
G	I	II	III
H	I	II	III ¹
I	NO RESTRICTIONS		
J	NO RESTRICTIONS		

¹In rooms in which personal liberties of inmates are forcibly restrained, Class I material only may be used.

²Over two stories shall be of Class II.

4. All interior wall or ceiling finish other than Class I material which is less than one-fourth inch ($\frac{1}{4}$ ") thick shall be applied directly against an incombustible backing unless the qualifying tests were made with the material suspended from the incombustible backing.

**Finishes
Based on
Occupancy**

Sec. 4204. The minimum flame-spread classification of interior finish, as determined by tests, shall be based on use or occupancy as set forth in Table No. 42-B.

EXCEPTIONS: 1. Except in Group D Occupancy and in enclosed vertical exitways, Class III may be used in other exitways and rooms as wainscoting extending not more than forty-eight inches (48") above the floor and for tack and bulletin boards covering not more than five per cent of the gross wall area of the room.

2. Where approved full fire-extinguishing system protection is provided, the flame-spread classification rating may be reduced one classification, but in no case shall materials having a classification greater than Class III be used.

3. The exposed faces of Type III-H.T., structural members and Type III-H.T., decking and planking, where otherwise permissible under this Code are excluded from flame-spread requirements.

CHAPTER 43—FIRE-RESISTIVE STANDARDS

Sec. 4301. In addition to all the other requirements of this Code, fire-resistive materials shall meet the requirements for fire-resistive construction given in this Chapter. **General**

Sec. 4302. (a) **General.** Materials used for fire-resistive purposes shall be limited to those specified in this Chapter unless accepted under the procedure given in Section 4302 (b), and shall conform to the following standards: **Fire-Resistive Materials**

MATERIALS AND TESTS	U.B.C. DESIGNATION
FIRE TEST OF BUILDING CONSTRUCTION AND MATERIALS	43- 1-64
FIRE TESTS OF DOOR ASSEMBLIES	43- 2-64
TIN-CLAD FIRE DOORS AND SHUTTERS	43- 3-64
GYPSON WALLBOARD	47- 8-64
PROTECTION OF OPENINGS IN WALLS AND PARTITIONS AGAINST FIRE	43- 4-64
GYPSON LATH	47- 5-64
PLASTER	
Gypsum.....	47- 2-64
Portland Cement.....	26- 1-64

(b) **Tests.** For the purpose of determining the degree of fire resistance afforded, the materials of construction listed in this Chapter shall be assumed to have the fire-resistance ratings indicated. Any material or assembly of materials of construction tested in accordance with the requirements set forth in U.B.C. Standard No. 43-1-64 shall be rated for fire resistance in accordance with the results of such tests, provided that it also meets the performance standards as specified in Section 105.

(c) **Lath.** Gypsum lath shall be not less than three-eighths inch ($\frac{3}{8}$ ") in thickness and shall be perforated with holes not less than three-fourths inch ($\frac{3}{4}$ ") in diameter, except where plain gypsum lath is called for. Perforated gypsum lath shall have one hole for not more than each sixteen square inches (16 sq. in.) of lath surface. Application shall be as specified in Section 4703.

(d) **Plaster.** Plaster shall be gypsum or portland cement plaster not less than one-half inch ($\frac{1}{2}$ ") thick and shall conform to Chapter 47.

(e) **Concrete.** Grade A concrete is concrete in which at least 60 per cent of the coarse aggregate consists of pumice, limestone, calcareous gravel, trap rock, blast furnace slag, or burned clay or shale.

Grade B concrete is concrete in which at least 60 per cent of the coarse aggregate consists of granite, sandstone, cinders, or a mixture of any of these aggregates with aggregates for Grade A concrete.

**Fire-Resistive
Materials
(Continued)**

Grade C concrete is any concrete not classed as Grade A or B.

Where the classification is in doubt, concrete shall be assumed to be Grade C unless tests on the aggregates by an approved agency prove otherwise.

(f) **Pneumatically Placed Concrete.** Pneumatically placed concrete without coarse aggregate shall be classified as Grade A, B, or C concrete in accordance with the aggregate used.

**Protection of
Structural
Members**

Sec. 4303. (a) Protective Coverings. 1. Thickness of protection. The thickness of fire-resistive materials for protection of structural members shall be not less than that set forth in Table No. 43-A, except as modified in this Section. The figures shown shall be the net thickness of the protecting materials and shall not include any hollow space back of the protection.

2. **Unit masonry protection.** Unit masonry protection for metal columns shall have metal ties embedded in each transverse joint, where joints are more than sixteen inches (16") apart, and shall be spaced not more than sixteen inches (16") in other cases. Soffit tile protecting beam and girder flanges shall be tied to the flange. Ties shall have a cross-sectional area equal to that of No. 8 gauge wire.

3. **Reinforcement for cast-in-place protection.** Cast-in-place protection for metal structural members shall be reinforced at the edges of such members with wire or mesh with a maximum spacing of six inches (6") wound around or attached to the member. The sum of the cross-sectional area in each direction shall be not less than 0.025 square inches per foot.

4. **Embedment of pipes.** Conduits and pipes shall not be embedded in required fire protection of structural members.

5. **Column jacketing.** Where the fire-resistive covering on columns is exposed to injury from moving vehicles, the handling of merchandise, or by other means, it shall be jacketed to a minimum height of six feet (6') from the floor with an adequate protective covering.

6. **Ceiling protection.** Where a ceiling is used to fire protect floors or roofs, the constructions and their supporting structural members (beams and girders) need not be individually fire protected except where such members support loads from more than one floor or roof. Ceilings shall be continuous, but may have openings for incombustible pipes, ducts, and electrical outlets, provided the areas of such duct and outlet openings through the ceiling aggregate not more than one hundred square inches (100 sq. in.) in each one hundred square feet (100 sq. ft.) of ceiling area. All duct openings in such ceiling shall be protected by approved fire dampers.

(b) **Protected Members. 1. Attached metal members.** The edges of lugs, brackets, rivets, and bolt heads attached to

structural members may extend to within one inch (1") of the surface of the fire protection.

2. **Reinforcing.** Thickness of protection for concrete or masonry reinforcement shall be measured to the outside of the reinforcement, except that stirrups and ties may project not more than one-half inch ($\frac{1}{2}$ ") into the protection.

3. **Steel studs and joists.** Steel studs and joists are not required to have individual protection when part of an assembly which has a fire-resistive rating.

(c) **Fire Protection Omitted.** Fire protection may be omitted from the bottom flange of lintels, shelf angles, or plates that are not a part of the structural frame.

Sec. 4304. (a) General. Fire-resistive walls and partitions shall have the ratings set forth in Table No. 43-B.

(b) **Combustible Members.** Combustible members framed into a wall shall be protected at their ends by not less than one-half the required fire-resistive thickness of such wall.

Sec. 4305. (a) General. Fire-resistive floors or ceilings shall have the ratings set forth in Table No. 43-C.

(b) **Ceilings.** Where a ceiling of lath and plaster as approved for one-hour fire-resistive construction as specified in this Chapter is used below slabs or structural members not otherwise required to be protected by such a ceiling, the required thickness of slab and fire protection of structural members may be reduced one-half inch ($\frac{1}{2}$ ") but in no case shall the slab thickness be less than two inches (2").

(c) **Unusable Space Above or Below.** In one-hour fire-resistive construction the ceiling may be omitted over unusable space and flooring may be omitted where unusable space occurs above.

Sec. 4306. (a) General. Fire assemblies wherever specified in this Code shall meet the requirements of this Chapter.

(b) **Definitions. FIRE ASSEMBLY.** Fire assembly is the assembly of a fire door, fire window, or fire shutter, including all required hardware, anchorage, door frames and sills.

FIRE ASSEMBLY, AUTOMATIC is a fire assembly which may remain in an open position and which will close automatically if subjected to either of the following:

1. An increase in temperature;
2. Products of combustion.

Unless otherwise specified, the closing device shall be activated at a maximum temperature of 165°F. If products of combustion are being detected to actuate the closing device, the closing device shall operate by the activation of a detector set to operate when smoke reduces the intensity of a one-foot

(Continued on page 374)

**Protection of
Structural
Members
(Continued)**

**Walls and
Partitions**

**Floors
and Ceilings**

**Fire-Resistive
Assemblies for
Protection
of Openings**

TABLE NO. 43-A—MINIMUM PROTECTION OF STRUCTURAL PARTS BASED ON TIME PERIODS FOR VARIOUS INCOMBUSTIBLE INSULATING MATERIALS

STRUCTURAL PARTS TO BE PROTECTED	INSULATING MATERIAL USED	MINIMUM THICKNESS OF MATERIAL FOR THE FOLLOWING FIRE-RESISTIVE PERIODS (Inches)			
		4 hr.	3 hr.	2 hr.	1 hr.
Steel or Cast Iron Columns; Projecting Steel Beam or Girder Flanges; All Members of Primary Trusses	Grade A concrete	2	2	1½	1
	Grade B concrete	2½	2	1½	1½
	Grade C concrete	3	2½	2	1½
	Brick of clay, shale, concrete or sand-lime	3¾	3¾	2¼	1¼
	Clay tile, clay tile and concrete or concrete block ^{1, 2}	4 or 2 Pl.	4 or 2 Pl.	2	2
	Solid gypsum blocks ^{1, 2}	2 Pl.	2 Pl.	2	2
	Hollow gypsum blocks ^{1, 2}	3 Pl.	3	2	2
	Poured gypsum	2	1½	1	1
	Metal lath and portland cement plaster			2¾ ³	1
	Metal lath and gypsum plaster			2¼ ³	¾
	Two ½" layers plain long-length gypsum lath ⁴ wrapped with wire netting. Thickness approved vermiculite-gypsum plaster	1½	1		
	One ¾" perforated gypsum lath ⁴ , no netting. Thickness approved vermiculite-gypsum plaster			1	
	Paperbacked wire fabric wrapped directly around column ⁵ ; thickness approved vermiculite concrete ⁶	2			

TABLE NO. 43-A—Continued

STRUCTURAL PARTS TO BE PROTECTED	INSULATING MATERIAL USED	MINIMUM THICKNESS OF MATERIAL FOR THE FOLLOWING FIRE- RESISTIVE PERIODS (Inches)			
		4 hr.	3 hr.	2 hr.	1 hr.
Steel or Cast Iron Columns; Projecting Steel Beam or Gir- der Flanges; All Members of Primary Trusses (Continued)	Metal lath and approved vermiculite-gypsum plaster	1½ ⁷ 1 ⁸	1 ⁷ ¾	¾	¾
	Approved perlite-gypsum plaster over self-furring metal lath wrapped directly around column	1¾	1¾	1	
	Approved perlite-gypsum plaster over metal lath furred 1½" from column with ¾" channel brackets at 2' vertical spacing	1½			
	Approved vermiculite-gypsum plaster over self-furring metal lath wrapped directly around column	1¾	1¾		
	Plain long-length gypsum lath, 2 layers, ½" ^{4, 9} . Approved vermiculite-gypsum or approved perlite-gypsum plaster	1½	1		
	Plain long-length gypsum lath, ½", 1 layer ^{4, 10} . Approved vermiculite-gypsum or approved perlite-gypsum plaster		1½		
	Perforated gypsum lath, ¾" ⁴ . Approved vermiculite or approved perlite-gypsum plaster		1¾	1	
	Perforated gypsum lath, ¾" ⁴ . Gypsum sanded plaster			1¾	½

⁷See footnotes on page 373.

TABLE NO. 43-A—MINIMUM PROTECTION OF STRUCTURAL PARTS BASED ON TIME PERIODS FOR VARIOUS INCOMBUSTIBLE INSULATING MATERIALS (Continued)

STRUCTURAL PARTS TO BE PROTECTED	INSULATING MATERIAL USED	MINIMUM THICKNESS OF MATERIAL FOR THE FOLLOWING FIRE-RESISTIVE PERIODS (Inches)			
		4 hr.	3 hr.	2 hr.	1 hr.
Webs of Steel Beams and Girders	Grade A concrete	2	1½	1	1
	Grade B concrete	2½	2	1½	1
	Grade C concrete	3	2½	1½	1
	Brick of clay, shale, concrete or sand-lime	3¾	2¼	2¼	2¼
	Clay tile, clay tile and concrete or concrete block	3 or 2 Pl.	2	2	2
	Solid gypsum block	2 Pl.	2	2	2
	Hollow gypsum block	3 Pl.	2	2	2
	Poured gypsum	2	1½	1	1
	Metal lath and approved vermiculite-gypsum plaster	1 ^s	¾	¾	¾
	Metal lath and gypsum or portland cement plaster			2	¾
Reinforcing Steel in Reinforced Concrete Columns, Beams, Girders and Trusses	Grade A or B concrete	1½	1½	1½	1
	Grade C concrete	2	1½	1½	1

TABLE NO. 43-A—Continued

Reinforcing Steel in Reinforced Concrete Joists	Grade A or B concrete	1 1/4	1 1/4	1	3/4
	Grade C concrete	1 3/4	1 1/2	1	3/4
Ceiling Protection for Steel Roof Members Including Steel Roof Trusses and Secondary Trusses	Metal or wire lath and gypsum or cement plaster, concrete, burned clay products or gypsum	2	1 1/2	1	3/4
	Metal lath and approved vermiculite-gypsum plaster	1 ^a	3/4	3/4	3/4
Reinforcing and Tie Rods in Floor and Roof Slabs	Grade A or B concrete ¹¹	1	1	3/4	3/4
	Grade C concrete ¹¹	1 1/4	1	1	3/4
	Gypsum ¹¹	1	1	3/4	3/4

¹Pl. in Table No. 43-A shall not be less than 1/2" gypsum or cement plaster.

²Re-entrant parts of protected members shall be filled solid for four- and three-hour protections.

³Two layers with 3/4" air space between.

⁴Lath applied tight against column flanges.

⁵Additional wire fabric 2" x 2" 16/16 gauge steel wire (without paperbacking) placed 3/4" from surface of concrete.

⁶Proportioned—one cubic foot (94-pound) portland cement to four cubic feet of approved vermiculite aggregate.

⁷Thickness required for column protection. Lath spaced 1 1/4" from column. Space behind lath on flange faces filled with plaster.

⁸3/8" of approved vermiculite-gypsum plaster plus 1/2" of approved vermiculite acoustical plastic may be used.

⁹Wire fabric, 1" mesh 20-gauge wire, wrapped around the lath.

¹⁰Wire fabric, 1" mesh 20-gauge wire, between the two coats of plaster.

¹¹Thickness includes gypsum or cement plaster.

**Fire-Resistive
Assemblies for
Protection
of Openings
(Continued)**

(1') long beam of white light by four per cent, or any other detector which will operate within that limitation.

FIRE ASSEMBLY, SELF-CLOSING. Fire assembly, self-closing is a fire assembly which is kept in a normally closed position and is equipped with an approved device to insure closing and latching after having been opened for use.

(c) **Classification of Openings.** All fire assemblies having fire-resistive ratings of three, two, one and one-half, one, and three-fourths hours shall bear the label or other identification showing the fire-resistive rating thereof. Such label shall be issued by an approved testing agency having a service for the inspection of materials and workmanship at the factory during fabrication and assembly.

EXCEPTION: A three-fourths-hour fire-resistive labeled assembly may be used where a one-hour door is required provided the door was tested, together with a type of hardware not necessarily specified in this Code, for a period of one hour in accordance with the requirements set forth in U.B.C. Standard No. 43-2-64.

(d) **Fire-resistive Tests.** The fire-resistive rating of all types of required fire-resistive assemblies shall be determined in accordance with the requirements set forth in U.B.C. Standard No. 43-2-64. A minimum transmitted temperature endpoint shall not be required.

(e) **Hardware.** Every fire assembly required to have a three-hour fire-resistive rating shall be of an automatic type as defined in Section 4306 (b). Every fire assembly required to have a two-hour, one and one-half-hour, one-hour or three-fourths-hour fire-resistive rating shall be of an automatic or self-closing type as defined in Section 4306 (b).

EXCEPTIONS: 1. Dual purpose fire-exit doors may have closing devices as set forth in Table No. 33-B.

2. Closing devices may be omitted on three-fourths-hour fire-resistive assemblies required as protection for openings in exterior walls and inner court walls by Section 504 and Parts IV and V.

Heat-actuated devices used in automatic fire assemblies shall be installed, one on each side of the wall at the top of the opening and one on each side of the wall at ceiling height where the ceiling is more than three feet (3') above the opening.

Devices detecting products of combustion when required shall meet the approval of the Fire Department as to installation and location and shall be subject to such periodic tests as may be required.

(Continued on page 384)

TABLE NO. 43-B—RATED FIRE-RESISTIVE PERIODS FOR VARIOUS WALLS AND PARTITIONS

MATERIAL	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE (INCLUDING PLASTER WHERE MENTIONED) In inches			
		4 hr.	3 hr.	2 hr.	1 hr.
Brick of Clay, Shale, Sand-Lime or Concrete, and Plain Concrete	Solid unplastered	8			4'
	Solid plastered	9		5'	
	Hollow (rowlock) unplastered	12	10	8	
	Hollow (rowlock) plastered	9			
Hollow Clay Tile, Wall	End or side construction. One cell in wall thickness. Plastered				3'
	End or side construction. Two cells in 8" or less thickness. Unplastered	16	12		6' or 8
	End or side construction. Two cells in 8" or less thickness. Plastered	13	9	7'	
Hollow Clay Tile, Load- Bearing (U.B.C. Standard No. 24-7-64)	End or side construction. Two cells in wall thickness. Unplastered			6'	
	End or side construction. Two cells in wall thickness. Plastered			5'	
	End or side construction. Three cells in 8" or less thickness. Unplastered	12			
	End or side construction. Three cells in 8" or less thickness. Plastered one side		8½		
	End or side construction. Three cells in 8" or less thickness. Plastered	9			
Combination of Brick and Load-bearing Tile (U.B.C. Standard No. 24-7-64) or Hollow Concrete Block or Tile	4" brick and 4" tile. Plastered one side (tile side)	9			

See footnotes page 379.

TABLE NO. 43-B—RATED FIRE-RESISTIVE PERIODS FOR VARIOUS WALLS AND PARTITIONS—Continued

MATERIAL	CONSTRUCTION			MINIMUM FINISHED THICKNESS FACE-TO-FACE (INCLUDING PLASTER WHERE MENTIONED) in inches			
				4 hr.	3 hr.	2 hr.	1 hr.
Concrete Masonry Units	Aggregate— Expanded Slag, Burned Clay or Shale, Cinders	1 ¼" face Shells	Unplastered			8	4 ²
			Plastered one side		8 ½	4 ½ ²	
		1 ½" face Shells	Unplastered	12 ³	8		
			Plastered each side	9			
		2 ¼" face Shells	Unplastered	8			
	Other Aggregates—	1 ⅝" face Shells	Unplastered			8	4 ²
			Plastered each side		9	5 ²	
		1 ¾" face Shells	Unplastered	12	8		
			Plastered each side	9			
		2 ¼" face Shells	Unplastered	8			
Solid Concrete	Reinforcement not less than 0.2% in each direction			6	5	4	2 ¹
Hollow Gypsum Blocks	Unplastered			6 ¹	5 ¹	4 ¹	3 ¹
	Plastered each side			5 ¹	4 ¹	4 ¹	3 ¹
Glazed or Unglazed Facing Tile (Nonbearing)	Cored not in excess of 25%, two units in wall thickness with mortar filled collar joint				6 ¹		
	Two inches cored not in excess of 25% and 4" structural tile, cored not in excess of 40%, collar joint mortar filled, plastered on one side with ¾" gypsum-sand plaster				6 ¹		
	Cored not in excess of 25%, plastered with ¾" gypsum-sand plaster					4 ¹	
	Cored not in excess of 30%, plastered with ¾" approved vermiculite-gypsum plaster					4 ¹	

TABLE NO. 43-B—Continued

Glazed or Unglazed Facing Tile (Nonbearing)	Meeting requirements of U.B.C. Standard No. 24-9-64, except that shells of solid shell horizontal cell units shall be not less than $\frac{3}{8}$ " thick, plastered with $\frac{3}{8}$ " gypsum-sand and plaster —(1:3 by volume)				4 ¹
Hollow Wall of Reinforced Pneumatically Placed Concrete	Outer shell 2" thick for 10" wall and 1½" thick for 8" wall	10 ¹	8 ¹		
Solid Gypsum or Portland Cement Plaster	Incombustible studding with metal or wire lath				2 ¹
	Incombustible studding with metal or wire lath, neat wood fiber gypsum plaster			2 ¹	
	Studless partition, incombustible runners, $\frac{3}{8}$ " or $\frac{1}{2}$ " plain gypsum lath, gypsum plaster ⁴ each side				2 ¹
	Incombustible studding with metal or wire lath, approved vermiculite-gypsum or approved perlite-gypsum plaster			2½ ¹	2 ¹
	Studless partition, incombustible runners, $\frac{1}{2}$ " plain gypsum-lath approved vermiculite-gypsum or approved perlite-gypsum plaster each side			2½ ¹	2 ¹
	Studless partition with diamond mesh or $\frac{3}{8}$ " rib lath, gypsum sanded plaster				2 ¹
Solid Gypsum Wallboard Partition	One layer $\frac{1}{2}$ " Type "X" wallboard laminated to each side of 1" V-Edged coreboards with approved laminating compound. Vertical joints of face layer and coreboard are staggered 3" or more. Joints are taped and finished			2 ¹	

TABLE NO. 43-B—RATED FIRE-RESISTIVE PERIODS FOR VARIOUS WALLS AND PARTITIONS (Continued)

MATERIAL	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE (INCLUDING PLASTER WHERE MENTIONED) In Inches			
		4 hr.	3 hr.	2 hr.	1 hr.
Interior Stud Partition with Plaster on each side	Incombustible studding with metal or wire lath, $\frac{3}{4}$ " gypsum plaster on each side				3
	Incombustible studding with metal or wire lath, 1" gypsum plaster on each side			4½	
	Wood studs with metal or wire lath. Firestopped. $\frac{3}{4}$ " gypsum plaster on each side				3' or 5
	Wood studs with metal or wire lath. Firestopped. 1" neat wood fiber plaster each side			5'	
	Wood studs with $\frac{3}{8}$ " perforated gypsum lath. Firestopped. $\frac{1}{2}$ " gypsum plaster each side				3' or 5
	Wood studs with $\frac{3}{8}$ " perforated gypsum lath with 1" mesh No. 20 gauge gal. wire furred out $\frac{1}{8}$ " and 1" approved perlite gypsum or approved vermiculite-gypsum plaster each side. The No. 20 gauge wire is attached with No. 12 gauge by 1¼" galvanized furring nails spaced 8" on center			6¾	
Interior Stud Partition with Gypsum Wallboard on each side	Wood studs with two layers of $\frac{3}{8}$ " gypsum wallboard each side. First layer nailed to studs in vertical position. Face layer laminated to base layer in horizontal position with joints staggered using gypsum joint cement and nails				5
	Wood studs with space between filled with mineral wool bats ⁷ nailed to studs, $\frac{1}{2}$ " gypsum wallboard each side				4½
	Wood studs with two layers of $\frac{1}{2}$ " gypsum wallboard each side, joints staggered				5½

TABLE NO. 43-B—Continued

Interior Stud Partition with Gypsum Wallboard on each side	Wood studs with one layer of $\frac{5}{8}$ " Type "X" gypsum wallboard nailed ² 7" on center to each side with end joints on nailing members. Joints taped and finished. (Firestopped)				4 $\frac{1}{8}$
	Wood studs with two layers of $\frac{5}{8}$ " Type "X" gypsum wallboard each side. Base layers applied vertically and nailed ³ 9" on center. Face layers applied vertically or horizontally and nailed ⁴ 7" on center. For nail-adhesive application base layers are nailed ⁵ 6" on center. Face layers applied with coating of wallboard adhesive and nailed ⁵ 12" on center. Face layer joints taped and finished. (Firestopped)				6 $\frac{1}{8}$
Exterior Stud Wall	Drop siding over $\frac{1}{2}$ " gypsum sheathing on exterior surface with interior surface treatment as required for interior stud partitions				5%
	Incombustible or wood studs with metal or wire lath and $\frac{7}{8}$ " exterior cement plaster on the exterior surface with interior surface treatment as required for interior stud partitions				5 $\frac{1}{2}$
	Wood studs with one layer of $\frac{5}{8}$ " Type "X" gypsum wallboard nailed ² 7" on center on the inside with end joints on nailing members. Covered on the exterior with one of the materials specified above. Joints taped and finished. (Firestopped)				5 $\frac{1}{8}$
	Incombustible studs with metal or wire lath and 1" exterior cement plaster on the exterior surface with interior surface treatment as required for two-hour fire-resistive interior stud partitions				4 $\frac{1}{2}$

¹Shall be used for nonbearing purposes only.²Seven-eighths-inch ($\frac{7}{8}$ ") face shells.³Eight inches (8") for expanded slag.⁴One part gypsum to one part sand by weight for scratch coat and one part gypsum to two parts sand by weight for brown coat.⁵Six-penny, No. 13 gauge, one and seven-eighths inches (1 $\frac{7}{8}$ ") long, one-fourth-inch ($\frac{1}{4}$ ") diameter, flat head nail.⁶Eight-penny, No. 11 $\frac{1}{2}$ gauge, two and three-eighths inches (2 $\frac{3}{8}$ ") long, flat head nail.⁷Mineral or slag wool bats shall weigh not less than 1.0 lb. and glass wool bats not less than 0.6 lb. per square foot of wall surface.

TABLE NO. 43-C—MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS

TABLE NO. 43-C

UNIFORM BUILDING CODE

MATERIAL	CONSTRUCTION	MINIMUM THICKNESS OF FLOOR OR ROOF SLAB (Inches)				MINIMUM THICKNESS OF CEILING (Inches)			
		4 hr.	3 hr.	2 hr.	1 hr.	4 hr.	3 hr.	2 hr.	1 hr.
Concrete	Slab or arch (no ceiling required)	6½	5½	4½	3½				
Solid masonry or gypsum	Slab or arch (no ceiling required)	4	3	2½	2½				
Hollow masonry	Slab or arch	4¹	3½¹	3¹	3				
Reinforced concrete joists	Slab with suspended ceiling on metal or wire lath, gypsum or portland cement plaster²			2½	2			¾	¾
	Slab with suspended ceiling, approved gypsum-vermiculite plaster over metal lath	3	2			1	¾		
	Slab (no ceiling required)				3				
Steel joist or light steel construction, with attached or suspended ceiling of metal or wire lath	Concrete or gypsum slab with gypsum plaster ceiling	2½	2½	2¼	2	2.	1¹	¾	¾
	Concrete or gypsum slab with approved gypsum-vermiculite ceiling	2½	2½	2	2	1¹	¾	¾	¾
	Concrete or gypsum slab with ceiling, portland cement plaster²				2				¾
	T. & G. wood flooring on wood stripping with gypsum plaster ceiling				1 nom.				¾

See footnotes on page 383.

TABLE NO. 43-C—Continued

Steel joist or light steel construction with attached or suspended ceiling of $\frac{3}{8}$ " perforated gypsum lath attached with clips giving continuous support to lath and plastered with vermiculite or approved perlite-gypsum plaster	Concrete or gypsum slab 2" in thickness when ceiling is one of the five ceilings specified below							
	Ceiling, $\frac{5}{8}$ " plaster, $\frac{3}{4}$ " channels 16" on center			2				1
	Ceiling, $\frac{1}{2}$ " plaster, $\frac{3}{4}$ " channels 16" on center, 14 gauge diagonal wire ^b		2				$\frac{7}{8}$	
	Ceiling, $\frac{1}{2}$ " plaster, $\frac{3}{4}$ " channels 16" on center, plaster reinforcement with 20-gauge 1" wire mesh ^c	2				$\frac{7}{8}$		
	Ceiling, $\frac{5}{8}$ " plaster, $\frac{3}{4}$ " channels 12" on center, 14-gauge diagonal wire ^b	2				1		
	Ceiling, 1" plaster, $\frac{3}{4}$ " channels 12" on center, plaster reinforcement with 20-gauge 1" wire mesh ^c	2				1 $\frac{3}{8}$		
Steel joist or light steel construction with attached or suspended ceiling of $\frac{3}{8}$ " perforated gypsum lath attached with clips giving continuous support to lath and plastered with sanded gypsum plaster	Concrete or gypsum slab 2" thick with ceiling, $\frac{5}{8}$ " plaster, $\frac{3}{4}$ " channels 12" on center with No. 14 gauge diagonal wire			2			1	

TABLE NO. 43-C—MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS—Continued

MATERIAL	CONSTRUCTION	MINIMUM THICKNESS OF FLOOR OR ROOF SLAB (Inches)				MINIMUM THICKNESS OF CEILING (Inches)			
		4 hr.	3 hr.	2 hr.	1 hr.	4 hr.	3 hr.	2 hr.	1 hr.
Poured gypsum slab on unprotected steel bulb-tees ¹	Reinforced gypsum slab on ½" gypsum formboard on tees 32 5/8" on center			2 ½	2				
Steel roof deck on steel framing with suspended ceiling of metal or wire lath	Fiberboard insulation or wood fiber and cement binder on top of deck, with ceiling, gypsum plaster sanded 1:2			1 ½	1			7/8	¾
	Wood sheathing or fiberboard insulation on top of deck, with ceiling, gypsum or portland cement plaster ²				1				¾
Steel or precast concrete joists with attached or suspended ceiling of metal or wire lath	Double wood floor with building paper between, with ceiling, gypsum or portland cement plaster ²				1 ½				¾
Wood joists with subfloor of 1" nom. boarding or 5/8" plywood, a layer of building paper and ½" T. & G. flooring.	Attached ceiling of gypsum lath ¹ and gypsum plaster sanded 1:2								7/8
	Attached ceiling of gypsum lath and approved gypsum-vermiculite or approved perlite plaster								7/8

TABLE NO. 43-C—Continued

Wood joists with subfloor of 1" nominal boarding, or $\frac{5}{8}$ " plywood, a layer of building paper and $\frac{1}{2}$ " T. & G. flooring	Attached or suspended ceiling of metal lath and gypsum or portland cement plaster ¹							$\frac{3}{4}$
	Attached ceiling of metal lath and approved vermiculite-gypsum plaster							$\frac{3}{4}$
	Attached ceiling of one layer of $\frac{5}{8}$ " Type "X" gypsum wallboard nailed ⁹ 6" on center to joists with end joints on nailing members. Joints taped ¹⁰ and finished							$\frac{5}{8}$
	Attached ceiling of two layers of $\frac{1}{2}$ " gypsum wallboard with a separately attached 20-gauge 1" wire mesh between the two layers							1
Unprotected steel roof deck on individually protected steel framing	Approved vermiculite concrete ¹¹ over top of deck				3			

¹Requires top covering of solid masonry equal to $\frac{1}{2}$ thickness of slab or arch.

²Portland cement plaster with 15 pounds of hydrated lime and 3 pounds of asbestos fiber per bag of portland cement.

³Neat wood fiber gypsum plaster.

⁴Five-eighths inch of approved vermiculite-gypsum plus $\frac{1}{2}$ " of approved vermiculite acoustical plastic may also be used.

⁵14-gauge galvanized wire secured diagonally to clips or channels at each intersection.

⁶Wire mesh tied to each furring channel at joint, between adjacent lath.

⁷Spans of the bulb-tees based upon allowable stresses set forth in Chapter 27 shall be reduced 15 per cent for the two-hour rating.

⁸All joints reinforced with 3" strips of metal lath.

⁹Six-penny, No. 13 gauge, one and seven-eighths inches ($1\frac{7}{8}$ ") long, one-fourth-inch ($\frac{1}{4}$ ") flat head nail.

¹⁰When V-Edge Type "X" gypsum backing board is used, joint treatment is not required.

¹¹Proportioned—one cubic foot (94-pound) portland cement to four cubic feet of approved vermiculite aggregate.

**Fire-Resistive
Assemblies for
Protection
of Openings
(Continued)**

(f) **Glazing.** Glazed openings shall not be permitted in a fire assembly required to have a three-hour or two-hour fire-resistive rating.

The area of glazed openings in fire assemblies required to have one and one-half-hour and one-hour fire-resistive ratings shall be limited to one hundred square inches (100 sq. in.) per wall opening, neither width nor height shall exceed twelve inches (12"), except that when the width is four inches (4") or less the height may be increased to a dimension which will produce an area not exceeding one hundred square inches (100 sq. in.). When both leaves of a pair of doors have observation panels the total area of the glazed openings shall not exceed one hundred square inches (100 sq. in.).

Glazed openings shall be limited to twelve hundred and ninety-six square inches (1296 sq. in.) in area per light when fire-resistive assemblies are required to have a three-fourths-hour fire-resistive rating.

EXCEPTIONS: 1. Dual purpose fire-exit doors may have glazed openings as set forth in Table No. 33-B.

2. Windows required to have a three-fourths-hour fire-resistive rating may have an area not greater than eighty-four square feet (84 sq. ft.) with neither width nor height exceeding twelve feet (12').

Glazing shall be glass not less than one-fourth inch ($\frac{1}{4}$ ") thick, and shall be reinforced with wire mesh No. 24 gauge or heavier with openings not larger than one inch (1") square. Glass shall be held in place by steel glazing angles except that in casement windows wire clips may be used.

(g) **Tin-clad Doors.** If constructed as set forth in U.B.C. Standard No. 43-3-64 tin-clad fire doors installed on each side of a fire wall shall be considered as providing a fire assembly having a three-hour fire-resistive rating provided each door bears the label of an approved testing agency showing the classification thereof.

(h) **Installation.** A fire assembly shall be installed as set forth in U.B.C. Standard No. 43-4-64.

(i) **Signs.** A sign or plaque shall be permanently displayed near or on each required fire door in letters not less than one inch (1") high to read as follows:

**FIRE DOOR
DO NOT OBSTRUCT**

**Roof
Coverings**

Sec. 4307. Fire-retardant roof coverings shall be as specified in Section 3203.

PART IX**REGULATIONS FOR USE OF PUBLIC STREETS
AND PROJECTIONS OVER PUBLIC PROPERTY****CHAPTER 44—PROTECTION OF PEDESTRIANS DURING
CONSTRUCTION OR DEMOLITION**

Sec. 4401. No person shall place or store any material or equipment necessary for the work under a building permit on a street, alley, or public sidewalk, nor shall any work be performed except in accordance with the provisions of this Chapter. **General**

No person shall perform any work on any building or structure, if by so doing he endangers pedestrians on the street that abuts the property line, unless the pedestrians are protected as specified in this Chapter.

Any material or structure temporarily occupying public property, including fences and walkways, shall be adequately lighted between sunset and sunrise.

Sec. 4402. Material or equipment necessary for the work under a building permit may be placed or stored on public property in the following locations: **Temporary Use of Streets and Alleys**

1. **In front of the building site.** In the one-third portion of the roadway of the street that is adjacent to the curb in front of the building site for which a permit has been issued; provided that no material or equipment shall be placed or stored within five feet (5') of any rail or any street railway track.

2. **In front of the adjoining site.** In the roadway of the street adjoining the building site for which a permit has been issued to the same extent and under the same restrictions as specified in Subsection (a).

A due waiver of claim against the city for damages on account of such placement or storage must be obtained from the owner of such property and filed in the office of the Building Official before such materials or equipment may be placed or stored.

3. **In the alley.** In the alley adjoining the building site for which a permit has been issued, provided that a clear and unobstructed roadway not less than ten feet (10') in width is maintained through such alley along the building site.

4. **Public sidewalk in front of building site.** On any portion of the public sidewalk in front of the building site for which a permit has been issued, except on the walkway required to be maintained.

**Restrictions
to Storage
on Public
Property**

Sec. 4403. Material and equipment necessary for work to be done under a permit shall not be placed or stored on public property so as to obstruct free and convenient approach to any fire hydrant, fire or police alarm box, utility box, catch basin, or manhole, or so as to interfere with the free flow of water in any street or alley gutter.

**Mixing Mortar
on Public
Property**

Sec. 4404. The mixing of mortar or concrete on public property shall be done in a mechanical mixer or in a tight box in such a manner as to prevent dripping or splashing on the public property.

**Protection of
Utilities**

Sec. 4405. A substantial protective frame and boarding shall be built around and over every street lamp, utility box, fire or police alarm box, fire hydrant, catch basin, and manhole that may be damaged by any work being done under the permit. This protection shall be maintained while such work is being done.

**Protection of
Pedestrians
on Public
Property**

Sec. 4406. (a) **Walkway.** A walkway not less than four feet (4') wide with a railing on the street side shall be maintained on the sidewalk in front of the building site during construction, alterations, or demolition.

(b) **Type of Protection Required.** Protection shall be provided for pedestrians as set forth in Table No. 44-A, and be constructed as specified in this Chapter.

Such protection shall be maintained in place and kept in good order for the entire length of time pedestrians on the street that abuts the property line may be endangered, and shall be completely removed as soon as such construction work permits.

(c) **Construction of Railings.** Railings shall be substantially built and not less than three feet (3') high.

(d) **Construction of Fences.** Fences shall be substantially built of tight boards eight feet (8') high above grade, placed on the side of the walkway nearest to the building site. Fences shall extend the entire length of the building site and each end shall be turned and extended to the building line.

Doorways may be cut in the fence if they are protected by doors and kept closed, except when opened to permit materials or persons to pass through.

(e) **Construction of Canopies.** The protective canopy shall have a clear height of eight feet (8') above the walkway. The roof shall be tightly boarded. Every canopy shall have a tight board fence built along its entire length, on the side thereof next to the building site. The fence shall be solid from the sidewalk or walkway to the canopy roof and each end shall be turned and extended solid to the building site.

TABLE NO. 44-A—TYPE OF PROTECTION REQUIRED FOR PEDESTRIANS

Protection of
Pedestrians
on Public
Property
(Continued)

HEIGHT OF CONSTRUCTION	DISTANCE FROM CONSTRUCTION TO WALKWAY	PROTECTION REQUIRED
Eight feet or less	Less than six feet	Railing
	Six feet or more	None
More than eight feet	Less than six feet	Fence and Canopy
	Six feet or more and one-fourth height of construction or less	Fence and Canopy
	Six feet or more and one-fourth to one- half height of construction	Fence
	Six feet or more and at least one-half height of construction	None

The entire structure shall be designed to carry the loads to be imposed on it, provided the minimum live load to be used in design shall be not less than 35 pounds per square foot, uniformly loaded.

If materials are stored or work is done on the roof of the canopy, the street sides and ends of the canopy roof shall be protected by a tight curb board not less than one foot (1') high and a railing not less than three feet (3') high.

The space under the canopy over the walkway and the approaches thereto shall be kept well lighted with artificial lighting continuously between sunset and sunrise.

Sec. 4407. When the area or a portion thereof occupied by a public sidewalk is to be excavated, the holder of the building permit shall construct a substantial temporary walkway not less than four feet (4') in width for pedestrian travel over the areas to be excavated or around the same.

Protection of
Sidewalk
Excavations

The walkway over the excavated area shall be designed for a uniform live load of 150 pounds per square foot. The walkway shall be provided with suitable ramps or stairs at each end and with a handrail not less than three feet (3') high along each side or with a railing on one side and a fence on the other, as the case may require.

The walkway around the excavated area shall be as close to the excavation on the street side as possible and constructed with a railing not less than three feet (3') high and a fence on the excavation side of the walkway.

CHAPTER 45—PERMANENT OCCUPANCY OF PUBLIC PROPERTY**General**

Sec. 4501. No part of any structure or any appendage thereto, except signs, shall project beyond the property line of the building site, except as specified in this Chapter.

Structures or appendages regulated by this Code shall be constructed of materials as specified in Section 1710 and Chapter 35.

The projection of any structure or appendage shall be the distance measured horizontally from the property line to the outermost point of the projection.

No provisions of this Chapter shall be construed to permit the violation of other laws or ordinances regulating the use and occupancy of public property.

**Projection
into Alleys**

Sec. 4502. No part of any structure or any appendage thereto shall project into any alley.

A curb or buffer block may project not more than nine inches (9") and not exceed a height of nine inches (9") above grade.

Footings located at least eight feet (8') below grade may project not more than twelve inches (12").

**Space
Below
Sidewalk**

Sec. 4503. The space adjoining a building below a sidewalk on public property may be used and occupied in connection with the building for any purpose not inconsistent with this Code or other laws or ordinances regulating the use and occupancy of such spaces on condition that the right so to use and occupy may be revoked by the city at any time and that the owner of the building will construct the necessary walls and footings to separate such space from the building and pay all costs and expenses attendant therewith.

Footings located at least eight feet (8') below grade may project not more than twelve inches (12").

**Balconies
and
Appendages**

Sec. 4504. Oriel windows, balconies, unroofed porches, cornices, belt courses, and appendages such as watertables, sills, capitals, bases, and architectural projections, may project over the public property of the building site a distance as determined by the clearance of the lowest point of the projection above the grade immediately below, as follows:

Clearance above grade less than eight feet (8')—no projection is permitted.

Clearance above grade over eight feet (8')—one inch (1") of projection is permitted for each additional inch of clearance, provided that no such projection shall exceed a distance of four feet (4').

Marquees

Sec. 4505. (a) General. For the purpose of this Section a marquee shall include any object or decoration attached to or a part of said marquee.

(b) Projection and Clearance. The horizontal clearance between a marquee and the curb line shall be not less than two feet (2').

A marquee projecting more than two-thirds of the distance from the property line to the curb line shall be not less than twelve feet (12') above the ground or pavement below.

A marquee projecting less than two-thirds of the distance from the property line to the curb line shall be not less than eight feet (8') above the ground or pavement below.

(c) Length. A marquee projecting more than two-thirds of the distance from the property line to the curb line shall not exceed twenty-five feet (25') in length along the direction of the street.

(d) Thickness. The maximum height or thickness of a marquee measured vertically from its lowest to its highest point shall not exceed three feet (3') when the marquee projects more than two-thirds of the distance from the property line to the curb line and shall not exceed nine feet (9') when the marquee is less than two-thirds of the distance from the property line to the curb line.

(e) Construction. A marquee shall be supported entirely from the building and constructed as specified under Types of Construction and shall be of incombustible material or, when of Type V construction, of not less than one-hour fire-resistive construction.

(f) Roof Construction. The roof or any part thereof may be a skylight, provided wire glass is used not less than one-fourth inch ($\frac{1}{4}$ ") thick with no single pane more than eighteen inches (18") wide.

Every roof and skylight of a marquee shall be sloped to downspouts which shall conduct any drainage from the marquee under the sidewalk to the curb.

(g) Location Prohibited. Every marquee shall be so located as not to interfere with the operation of any exterior standpipe or to obstruct the clear passage of stairways or exits from the building or the installation or maintenance of electroliers.

Sec. 4506. (a) Definition. **AWNING** is a movable shelter supported entirely from the exterior wall of a building and of a type which can be retracted, folded or collapsed against the face of a supporting building.

**Movable
Awnings or
Hoods**

Such awning or hood may extend over public property not more than seven feet (7') from the face of a supporting building nor within two feet (2') of the curb line measured horizontally.

**Movable
Awnings
or Hoods
(Continued)**

Collapsible awnings shall be so designed that they shall not block a required exit when collapsed.

Collapsible awnings, unless cloth covered, shall be designed for a vertical live load of not less than five pounds per square foot; except that snow load shall be used, if greater.

(b) **Movable Awnings or Hoods.** Movable awnings or hoods may have combustible coverings supported on incombustible frames attached to the building.

Such awning or hood may extend over the public property not more than two-thirds the distance from the property line to the nearest curb in front of the building site.

All portions of any awning shall be at least eight feet (8') above any public walkway.

EXCEPTION: Any valance attached to an awning shall be of cloth unless it is fabricated of the same material used for the roof of the awning. A metal valance may have a reinforcing member at or near the lower edge. The valance shall not project above the roof of the awning at the point of attachment and shall not extend more than twelve inches (12") below the roof of the awning at the point of attachment; nor shall any portion of a valance be less than seven feet (7') in height above a public way.

Doors

Sec. 4507. Doors, either fully opened or when opening, shall not project more than one foot (1') beyond the property line, except that in alleys no projection beyond the property line is permitted.

PART X

PLASTER AND WALLBOARD

CHAPTER 47—LATHING, PLASTERING AND INSTALLATION OF WALLBOARD

Sec. 4701. Lathing and plastering and installation of wallboard shall be done in the manner and with the materials specified in this Chapter, and when required for fire protection shall also comply with the provisions of Chapter 43. **General**

No plaster shall be applied until the lathing has been inspected and approved by the Building Official.

The Building Official may require that test holes be made in the wall for the purpose of determining the thickness and proportioning of the plaster, provided the permit holder has been notified 24 hours in advance of the time of making such test.

Sec. 4702. (a) General. Materials shall conform to the following standards: **Materials**

MATERIALS	U.B.C. DESIGNATION
AGGREGATE	
Sand.....	47- 1-64
Perlite.....	47- 1-64
Vermiculite.....	47- 1-64
GYPSUM PLASTER	47- 2-64
LIME	
Special Finishing Hydrated Lime (autoclaved) ..	47- 3-64
Quicklime for Structural Purposes	24-16-64
KEENE'S CEMENT	47- 4-64
PORTLAND CEMENT	
Type I, II, or III	26- 1-64
Type I-A, II-A, or III-A Air-entraining Portland Cement	24-14-64
WOOD LATH	47- 5-64
FIBER INSULATION LATH	22- 1-64
GYPSUM LATH	47- 6-64
METAL AND WIRE LATH, METAL	
ACCESSORIES AND CHANNELS	47- 7-64
GYPSUM WALLBOARD	47- 8-64

(b) Aggregate. Sand shall conform to U.B.C. Standard No. 47-1-64 and shall be washed when used with portland cement for scratch coat plastering. The amount of sand retained on a No. 8 sieve shall be not less than 10 per cent or more than 30 per cent.

Containers for perlite and vermiculite aggregate shall be marked indicating that the material therein conforms to U.B.C. Standard No. 47-1-64.

Materials
(Continued)TABLE NO. 47-A—TYPE OF LATH—MAXIMUM SPACING OF SUPPORTS—
METHOD OF ATTACHMENT

TYPE OF LATH	WOOD SUPPORTS				MAXIMUM	
	SPACING OF SUPPORTS (Inches)		SIZE AND TYPE OF NAIL	SPACING OF NAILS (In.)	OF METAL SUPPORTS (Inches)	
					Surfaces	
	Vert.	Horiz.			Vert.	Horiz.
$\frac{3}{8}$ " perf. gypsum lath ¹	16	16	1 $\frac{1}{8}$ " 13 ga. $\frac{1}{16}$ " dia. head blued nail	5	16	16 ²
$\frac{3}{8}$ " plain gypsum lath ¹	16	16	1 $\frac{1}{8}$ " 13 ga. $\frac{1}{16}$ " dia. head blued nail	5	16	16
$\frac{1}{2}$ " perf. gypsum lath ¹	16	16	1 $\frac{1}{4}$ " 13 ga. $\frac{1}{16}$ " dia. head blued nail	5	16	16
$\frac{1}{2}$ " plain gypsum lath ¹	24	24	1 $\frac{1}{4}$ " 13 ga. $\frac{1}{16}$ " dia. head blued nail	4	24	16
Wood lath	16	16	3d fine 16 ga. blued nails	—	—	—
$\frac{1}{2}$ " fiber insulation lath ³	16	16	1 $\frac{1}{8}$ " fiber-board nails or 4d box nails	4 $\frac{1}{2}$	—	—
1" fiber insulation lath ³	16	16	1 $\frac{3}{4}$ " fiber-board nails or 6d box nails	4 $\frac{1}{2}$	—	—
Metal and wire lath ⁴	See Table No. 47-B	—	4d common nails (bent over)	6	See Table No. 47-B	
Metal and wire lath ⁴	—	See Table No. 47-B	1 $\frac{1}{2}$ " 11 ga. $\frac{1}{16}$ " dia. head barbed nails	6	See Table No. 47-B	

Footnotes to Table No. 47-A on page 393.

(c) **Gypsum Plaster.** Gypsum plaster shall conform to U.B.C. Standard No. 47-2-64.

(d) **Lime.** Special finishing hydrated lime (autoclaved) shall conform to U.B.C. Standard No. 47-3-64.

Quicklime used for structural purposes shall conform to U.B.C. Standard No. 24-16-64. Lime putty shall be made from quicklime or hydrated lime and shall be prepared in an approved manner.

(e) **Keene Cement.** Keene cement shall conform to U.B.C. Standard No. 47-4-64.

FOOTNOTES TO TABLE NO. 47-A

Materials
(Continued)

¹Gypsum lath shall be applied to wood supports with joints broken in each course except that end joints may fall on one support when stripped with three inches (3") of metal or wire lath. Joints between walls and ceilings shall be staggered. Lath shall be butted together. Lath shall be secured to horizontal or vertical metal supports by means of approved clips.

²Sixteen-inch (16") spacing for clips giving continuous support to lath.

³End joints of fiber insulation lath, except in interlocking-type lath, shall be not less than three-sixteenths inch ($\frac{3}{16}$ ") wide. Shiplapped, tongued and grooved, or interlocking edges shall be fitted to moderate contact.

⁴Diamond mesh metal lath and wire lath shall be lapped at least one mesh at sides, but need not exceed one inch (1"). Rib metal lath with edge ribs greater than one-eighth inch ($\frac{1}{8}$ ") in depth shall be lapped at sides by nesting outside ribs. Rib metal lath with edge ribs no greater than one-eighth inch ($\frac{1}{8}$ ") in depth shall be lapped at least one-half inch ($\frac{1}{2}$ ") at sides or outside ribs shall be nested. Lath shall be lapped at least one mesh at ends, but need not exceed one inch (1"). Lath shall be attached to horizontal and vertical metal supports so as not to exceed six-inch (6") spacing with not less than No. 18 U. S. steel wire gauge, galvanized annealed wire, or an equivalent approved attachment.

(f) **Portland Cement.** Types I, II and III portland cement shall conform to U.B.C. Standard No. 26-1-64.

Types I-A, II-A and III-A air-entraining portland cement shall conform to U.B.C. Standard No. 24-14-64.

For plastic or waterproof cement, see Exception, Subsection 2403 (o).

(g) **Wood Lath.** Wood lath shall conform to U.B.C. Standard No. 47-5-64.

(h) **Fiber Insulation Lath.** Fiber insulation lath shall conform to U.B.C. Standard No. 22-1-64.

(i) **Gypsum Lath.** Gypsum lath shall conform to U.B.C. Standard No. 47-6-64.

(j) **Metal and Wire Lath, Metal Accessories and Channels.** Metal and wire lath, metal accessories and channels shall conform to U.B.C. Standard No. 47-7-64.

(k) **Gypsum Wallboard.** Gypsum wallboard shall conform to U.B.C. Standard No. 47-8-64.

See. 4703. For gypsum, wood, and fiber insulation laths, the distance between supports shall conform to the requirements set forth in Table No. 47-A.

The weight of metal and wire lath and the spacing of supports shall conform to the requirements set forth in Table No. 47-B. Attachment to supports shall be as set forth in Table No. 47-A.

Cornerite shall be provided at all interior angles except where metal or wire lath is carried around such intersections. Cornerite shall consist of flat or shaped reinforcing units of metal which when shaped for angle reinforcing shall have minimum outstanding legs of two inches (2").

No interior lath shall be applied until all exterior framing is covered.

**Interior
Plastering:
Lathing**

**Interior
Plastering:
Lath and
Plaster
Partitions**

Sec. 4704. Hollow partitions of lath and plaster shall have a shell thickness of not less than three-fourths inch ($\frac{3}{4}$ ").

The minimum thickness of solid partitions of lath and plaster shall be not less than two inches (2") nor one eighty-fourth of the distance between supports. Studless solid partitions of metal lath and plaster or gypsum lath and plaster shall be not more than twelve feet (12') in height.

**Interior
Plastering:
Suspended and
Furred
Ceilings**

Sec. 4705. The main runners and cross furring shall be not less than the sizes set forth in Table No. 47-C, except that other shapes of hot-rolled or cold-rolled members of equal strength may be substituted for those prescribed in the table.

Hangers for suspended ceilings shall be not less than the sizes set forth in Table No. 47-C, fastened to or embedded in the structural framing, masonry, or concrete.

Hangers shall be saddle tied or wrapped around main runners so as to develop the full strength of the hangers. Lower ends of flat hangers shall be bolted with three-eighths-inch ($\frac{3}{8}$ ") bolts to runner channels, or bent tightly around runners and bolted to the main part of the hanger.

TABLE NO. 47-B—TYPES AND WEIGHTS OF METAL LATH, WIRE LATH, AND WIRE FABRIC, AND SPACING CENTER-TO-CENTER OF SUPPORTS¹

TYPE OF LATH	MINIMUM WT. OF LATH (lb. per sq. yd.)	MAXIMUM ALLOWABLE SPACING OF SUPPORTS (Inches)				
		VERTICAL SUPPORTS			HORIZONTAL SUPPORTS	
		Wood	Metal		Wood or Concrete	Metal
			Solid Partitions	Others		
Diamond mesh (flat expanded) metal lath	2.5	16	16	12	0	0
	3.4	16	16	16	16	13½
Flat rib expanded metal lath	2.75	16	16	16	16	12
	3.4	19	24	19	19	19
$\frac{3}{8}$ " rib expanded metal lath ²	3.4	24	—	24	24	24
	4.0	24	—	24	24	24
Sheet metal lath	4.5	24	—	24	24	24
Wire lath	2.48	16	16	16	13½	13½
V-stiffened wire lath	3.3	24	24	24	19	19
Wire fabric	3	16	0	16	16	16

¹Lath may be used on any spacings, center-to-center, up to the maximum shown for each type and weight.

²Rod-stiffened or V-stiffened diamond mesh (flat expanded) metal lath of equal rigidity and weight is permissible on the same spacing as three-eighths-inch ($\frac{3}{8}$ ") rib metal lath.

³Paperbacked wire fabric, No. 16 gauge wire, two-inch by two-inch (2" x 2") mesh, with stiffener.

TABLE NO. 47-C—SUSPENDED AND FURRED CEILINGS

Minimum Sizes for Wire and Rigid Hangers				
SIZE AND TYPE			MAXIMUM AREA SUPPORTED	SIZE
Hangers for Suspended Ceilings			12.5 sq. ft. 16 sq. ft. 18 sq. ft. 20 sq. ft. 22.5 sq. ft. 25.0 sq. ft.	9 gauge wire 8 gauge wire $\frac{3}{8}$ " diameter, mild steel rod ¹ $\frac{3}{16}$ " diameter, mild steel rod ¹ $\frac{1}{4}$ " diameter, mild steel rod ¹ 1" x $\frac{3}{16}$ ", mild steel flats ²
Hangers for Attaching Runners and Furring Directly to Beams and Joists	For Supporting Runners	Single Hangers Between Beams ³	8 sq. ft. 12 sq. ft. 16 sq. ft.	12 gauge wire 10 gauge wire 8 gauge wire
		Double Wire Loops at Beams or Joists ⁴	8 sq. ft. 12 sq. ft. 16 sq. ft.	14 gauge wire 12 gauge wire 11 gauge wire
	For Supporting Furring Without Runners ⁵ (Wire Loops at Supports)	Type of Support: Concrete Steel Wood	8 sq. ft.	14 gauge wire
			8 sq. ft. 8 sq. ft.	16 gauge wire (two loops) ⁴ 16 gauge wire (two loops) ⁴

¹All rod hangers shall be protected with a zinc or cadmium coating or with a rust-inhibitive paint.²All flat hangers shall be protected with a zinc or cadmium coating or with a rust-inhibitive paint.³Inserts, special clips or other devices of equal strength may be substituted for those specified.⁴Two loops of No. 18 gauge wire may be substituted for each loop of No. 16 gauge wire for attaching steel furring to steel or wood joists.⁵These spans are based on webs of channels being erected vertically.⁶Other sections of hot- or cold-rolled members of equivalent beam strength may be substituted for those specified.

Note: All gauges are U. S. steel wire gauges.

TABLE NO. 47-C—Continued

Minimum Sizes and Maximum Spans for Main Runners ^{1, 6}		
SIZE AND TYPE	MAXIMUM SPACING OF HANGERS OR SUPPORTS (Along Runners)	MAXIMUM SPACING OF RUNNERS (Transverse)
$\frac{3}{4}$ "—.3 lb. per ft., cold- or hot-rolled channel	2'0"	3'0"
1 $\frac{1}{2}$ "—.475 lb. per ft., cold-rolled channel	3'0"	4'0"
1 $\frac{1}{2}$ "—.475 lb. per ft., cold-rolled channel	3'6"	3'6"
1 $\frac{1}{2}$ "—.475 lb. per ft., cold-rolled channel	4'0"	3'0"
1 $\frac{1}{2}$ "—1.12 lb. per ft., hot-rolled channel	4'0"	5'0"
2"—1.26 lb. per ft., hot-rolled channel	5'0"	5'0"
2" cold-rolled channel, weighing not less than 590 lbs. per 1000 lin. ft.	5'0"	3'6"
1 $\frac{1}{2}$ " x 1 $\frac{1}{2}$ " x $\frac{1}{8}$ " angle	5'0"	5'0"
Minimum Sizes and Maximum Spans for Cross Furring ^{1, 6}		
SIZE AND TYPE	MAXIMUM SPACING OF RUNNERS OR SUPPORTS	MAXIMUM SPACING OF CROSS FURRING MEMBERS (Transverse)
$\frac{1}{4}$ " diameter pencil rods	2'0"	12"
$\frac{3}{8}$ " diameter pencil rods	2'0"	19"
$\frac{3}{8}$ " diameter pencil rods	2'6"	12"
$\frac{3}{4}$ "—.3 lb. per ft., cold- or hot-rolled channel	3'0"	24"
	3'6"	19"
	4'0"	16"
1"—.410 lb. per ft., hot-rolled channel	4'0"	24"
	4'6"	19"
	5'0"	12"

See footnotes on page 395.

Cross furring shall be securely attached to main runners by

- (1) saddle tying with No. 16 U. S. steel wire gauge galvanized wire,
- (2) with approved special clips, or
- (3) approved equivalent attachments.

Sec. 4706. (a) Number of Coats. Plastering with gypsum, lime, or portland cement plaster shall be three-coat work when applied over metal and wire lath, fiber insulation lath and wood lath, and shall be not less than two-coat work when applied over other plaster bases allowed in this Chapter.

**Interior
Plastering:
Number
of Coats
and Thickness**

Lime or portland cement plaster shall not be applied directly to fiber insulation lath or gypsum lath.

(b) **Thickness.** Grounds shall be installed to provide for the thickness of plaster, from face of plaster base to finished plaster surfaces, as set forth in Table No. 47-D.

If monolithic concrete ceiling surfaces require more than three-eighths inch ($\frac{3}{8}$ ") of plaster to produce desired lines or surfaces, metal lath or wire lath shall be attached thereto.

Exterior plaster, when reinforced as required by this Chapter, may be applied over gypsum lath on ceilings and roof soffits.

Sec. 4707. (a) Base Coats. 1. Gypsum or hardwall plaster. The proportion of sand, vermiculite, or perlite to 100 pounds of gypsum neat plaster shall not exceed the values set forth in Table No. 47-E.

**Interior
Plastering:
Proportioning
and Mixing**

2. **Wood-fiber gypsum plaster.** On lath, mix with water only. On masonry, mix in proportions of 100 pounds of plaster to not more than 100 pounds of sand.

3. **Lime plaster.** The proportioning of lime, Keene's cement, and fiber to one cubic yard of sand shall be not less than the values set forth in Table No. 47-F.

4. **Portland cement plaster.** The first two coats shall be as required for the first two coats of exterior work.

5. **Portland cement-lime plaster.** The first two coats shall be as required for the first two coats of exterior work.

(b) **Finish Coats for Gypsum, Lime, and Interior Portland Cement Plaster.** The finish coats shall be mixed, proportioned, and applied in an approved manner.

Sec. 4708. (a) Base Coats. 1. Gypsum plaster. The scratch coat shall be applied with sufficient material and pressure to form a full key or bond.

**Interior
Plastering:
Application
of Plaster**

For two-coat work it shall be doubled back to bring the plaster out to grounds and straightened to a true surface and left rough to receive the finish coat. For three-coat work, the surface shall be scratched to provide a bond for the brown coat and shall have been in place at least 12 hours before the second or brown coat is applied. The second or brown coat

**Interior
Plastering:
Application
of Plaster
(Continued)**

TABLE NO. 47-D—REQUIRED THICKNESS OF INTERIOR PLASTER

BACKING	THICKNESS OF PLASTER INCLUDING FINISH COAT FROM FACE OF PLASTER BASE (Inches)
Metal or Wire Lath	$\frac{5}{8}$ minimum ¹
All other types allowed	$\frac{1}{2}$ minimum
Unit Masonry and Concrete Walls	$\frac{5}{8}$ minimum
Monolithic Concrete Ceilings	$\frac{1}{8}$ minimum— $\frac{3}{8}$ maximum

¹Plaster thickness when measured from the back plane of metal lath, exclusive of ribs, shall be three-fourths-inch ($\frac{3}{4}$ ") minimum.

TABLE NO. 47-E—GYPSUM OR HARDWALL PLASTER

NUMBER OF COATS	COATS	DAMP, LOOSE SAND (Pounds)¹	VERMICULITE OR PERLITE (Cubic Feet)¹
Two-Coat Work (Double-up Method)	Base coat on gypsum lath	250	2 $\frac{1}{2}$
	Base coat on masonry (except over monolithic concrete)	300	3
Three-Coat Work	First (scratch) coat on lath	200 ²	2 ²
	First (scratch) coat on masonry	300	3
	All second (brown) coats	300 ²	3 ²

¹When determining the amount of aggregate in set plaster a tolerance of 10 per cent in the amount of aggregate shall be allowed.

²In lieu of the proportioning specified above, the proportions may be 100 pounds of gypsum neat plaster to not more than 250 pounds of damp, loose sand, or two and one-half cubic feet of vermiculite or perlite, provided this proportioning is used for both scratch and brown coats.

shall be brought out to grounds, and straightened to a true surface and left rough, ready to receive the finish coat.

2. **Lime plaster.** The first two coats shall be applied in the same manner as gypsum plaster, except that in three-coat work, the second coat (brown) shall be applied over a dry base coat.

3. **Portland cement plaster.** The first two coats shall be as required for the first two coats of exterior work, except that the interval between the first and second coats shall be not less than 24 hours.

TABLE NO. 47-F—LIME PLASTER

Interior
Plastering:
Application
of Plaster
(Continued)

NUMBER OF COATS	COATS	LIME (Cubic Feet or Pounds)	KEENE'S CEMENT (Pounds)	FIBER (Pounds)
Two-Coat Work on Masonry or Concrete	Base Coat	7 cubic feet lime putty or 300 pounds hydrated lime	150	4
Three-Coat Work on Metal and Wire Lath	First (scratch) coat	10 cubic feet lime putty or 450 pounds hydrated lime	200	6
	Second (brown) coat	7 cubic feet lime putty or 300 pounds hydrated lime	150	4

4. **Portland cement-lime plaster.** The first two coats shall be as required for the first two coats of exterior work, except that the interval between the first and second coats shall be not less than 24 hours.

(b) **Finish Coats.** 1. **Smooth white finish** shall be applied over base coat which has set and is surface-dry. Thickness shall be from one-sixteenth inch ($\frac{1}{16}$ ") to one-eighth inch ($\frac{1}{8}$ ").

2. **Sand-float finish** shall be applied over set base coat which is not quite dry.

3. **Keene's cement finish** shall be applied over set base coat which is not quite dry. Thickness shall be from one-sixteenth inch ($\frac{1}{16}$ ") to one-eighth inch ($\frac{1}{8}$ ").

4. **The finish coat** for interior portland cement plastering shall be applied in the same manner as required for the third coat of exterior portland cement plaster.

5. **Vermiculite finish** coat shall be applied over a base coat which is semi-green. Thickness shall be from one-sixteenth inch ($\frac{1}{16}$ ") to one-eighth inch ($\frac{1}{8}$ ").

(c) **Plaster on Monolithic Concrete.** Monolithic concrete surfaces shall be clean, free from efflorescence, damp, and sufficiently rough to insure adequate bond.

Gypsum plaster applied to monolithic concrete ceilings shall be specially prepared bond plaster for use on concrete, to which water only shall be added. Gypsum plaster on monolithic walls and columns shall be applied over a scratch coat of bond plaster before it has set. The brown coat shall be

**Interior
Plastering:
Application
of Plaster
(Continued)**

brought out to grounds, straightened to a true surface and left rough, ready to receive finish coat.

Lime plaster applied to concrete walls shall be as specified in Section 4707.

Portland cement plaster and portland cement-lime plaster applied to interior concrete walls or ceilings shall conform to requirements for application to exterior concrete walls as specified in Section 4711 (c).

**Interior
Plastering:
Staff**

Sec. 4709. Staff shall be soaked before sticking. Lugs shall be of pure fiber and plaster of Paris. Rust-resistive fastenings of sufficient strength to anchor the staff to the support shall be not less than No. 14 U. S. gauge copper wire.

**Exterior
Plastering:
Backing**

Sec. 4710. (a) **Definitions.** Exterior lathing and plastering shall be defined as all lathing and plastering applied to surfaces of walls, ceilings and roof soffits exposed to the weather except:

1. Ceilings and roof soffits enclosed by walls or by beams which extend a minimum of twelve inches (12") below the plastered surfaces.

2. Walls beyond a horizontal distance measured from vertical surfaces exposed to the weather and equal to twice the clear height of exterior openings unprotected by closures.

3. Ceilings and roof soffits beyond a horizontal distance of ten feet (10') from the outer edge of the ceilings or roof soffits.

(b) **Backing.** Studs shall be sheathed, or wire of not less than No. 18 U. S. steel wire gauge shall be stretched taut horizontally at intervals not exceeding six inches (6") on center vertically and securely fastened in place. This shall not be required with metal lath or paperbacked wire fabric.

EXCEPTION: On ceilings and roof soffits, gypsum lath may be used as a backing for exterior plaster when such plaster is reinforced as specified in this Chapter.

(c) **Weather Protection.** Weather protection shall be as specified in Section 1707 (a).

(d) **Metal Reinforcement.** Exterior plaster, except when applied to concrete or masonry, shall be reinforced with one of the materials having a rust-resistive coating as set forth in Table No. 47-G.

TABLE NO. 47-G—EXTERIOR PLASTER REINFORCEMENT

TYPE OF REINFORCEMENT	MINIMUM GAUGE	MINIMUM WEIGHT (Pounds per Square Yard)
Expanded Metal		1.8
Metal Lath		3.4
Welded or Woven Wire Netting	18	1.4
Welded Wire Fabric	16	1.0

Metal reinforcement shall be furred out from the backing at least one-fourth inch ($\frac{1}{4}$ ") by an approved furring method, and shall be nailed with galvanized nails or approved furring devices driven to at least three-fourths-inch ($\frac{3}{4}$ ") penetration which shall be spaced not more than six inches (6") apart vertically and sixteen inches (16") apart horizontally. Metal reinforcement shall be lapped at least one full mesh at all joints. When no sheathing is used, all vertical joints shall be made at the studs, and horizontal joints where expanded metal or metal lath is used shall have at least one tie between studs, made with No. 18 U. S. steel wire gauge galvanized annealed tie wire.

**Exterior
Plastering:
Backing
(Continued)**

(e) **Exterior Corner Beads.** Metal corner reinforcement for exterior plaster may be used when approved by the Building Official provided the corner reinforcements are treated for corrosion-protection and are formed to insure mechanical bond and a solid plaster corner.

Sec. 4711. (a) General. Exterior cement plaster shall be portland cement plaster meeting the requirements as set forth in Table No. 47-H, except when applied over concrete or masonry.

**Exterior
Plastering:
Application**

(b) **Plasticity Agents.** Plasticity agents shall be of approved types and when added in the mixing of plaster shall be used in an amount not exceeding 10 per cent of the volume of portland cement. When added in the manufacturing process conforming to the requirements of Section 4702, no later additions shall be made.

(c) **Application. 1. General.** Except when applied to concrete or masonry, and except as otherwise provided for pneumatically applied plaster, exterior cement plastering materials shall be mixed by machine methods for not less than two minutes, and shall be applied in three coats as set forth in Table No. 47-H.

The first coat shall be forced through all openings in the reinforcement so as to solidly fill all spaces. It shall then be scored horizontally with a scratcher having one-eighth-inch ($\frac{1}{8}$ ") clipped teeth and grooves not more than one-half inch ($\frac{1}{2}$ ") deep.

The second coat shall be rodded and water floated, with no variation greater than one-fourth inch ($\frac{1}{4}$ ") in any direction under a five-foot (5') straightedge.

2. **Plastering on masonry or concrete.** The masonry surface on which plaster is to be applied shall be clean, free of efflorescence, damp, and sufficiently rough to insure proper bond. Mixtures specified for the second coat in this Section may be applied directly to masonry.

3. **Application of reinforcement.** Exterior plaster reinforcement, string wires and paperbacking shall be applied as set forth in Table No. 47-I.

Exterior
Plastering:
Application
(Continued)

TABLE NO. 47-H—EXTERIOR PLASTER

COAT	CEMENT PLASTER Maximum Volume of Sand per Volume of Cement	CEMENT-LIME PLASTER		ALL EXTERIOR PLASTER		
		Maximum Volume of Lime per Volume of Cement	Maximum Volume of Sand per Volume of Combina- tion Cement and Lime ¹	Minimum Thickness (in Inches)	Minimum Period Moist Curing	Minimum Interval Before Applying Succeed- ing Coat
First or Scratch	4 ¹	$\frac{3}{4}$	3 $\frac{1}{4}$	$\frac{1}{2}$ ²	48 Hours	48 Hours ^{3,4}
Second or Brown	5 ¹	$\frac{3}{4}$	3 $\frac{3}{4}$	1st and 2nd Coats $\frac{3}{8}$	48 Hours	7 Days
Third or Finish	3		3 ⁵	$\frac{1}{8}$		

¹When determining the amount of aggregate in set plaster, a tolerance of 10 per cent in the amount of aggregate shall be allowed.

²Measured from backing to crest of scored plaster.

³To insure suction there should be a drying period after the moist curing period.

⁴When applied over gypsum lath backing, the brown coat of reinforced exterior cement plaster may be applied as soon as the first coat has become sufficiently hard.

⁵Third and finish coat may be of any materials and mixture approved as a finish coat for portland cement plaster.

Notes: No additions of plasticity agents shall be made in the manufacturing, or when mixing.

All other specifications set forth in Sections 4710, 4711, 4712 (a) 1, 2 and 3 will apply for portland cement-lime plaster.

Machine
Applied
Plaster

Sec. 4712. (a) Application. Machine-applied plaster shall conform to the following requirements:

1. Plaster, aggregate and water shall be mixed, (a) in a standard plaster mixer and transferred from the mixer to a hopper, or (b) mixed in a combination hopper and drum; or by other method approved by the Building Official.

2. Plaster shall then be projected into, and conveyed through a tube, flexible or rigid, to the nozzle at the end of the conveyor and deposited by pressure in its final position ready for manual straightening and finishing.

3. Plaster shall be applied in the same number of coats and of same thickness as required by this Chapter for gypsum plaster, for portland cement plaster, and for portland cement-lime plaster.

(b) **Proportions.** 1. Short-fibered or unfibered gypsum plaster, portland cement plaster. Machine-placed plasters shall consist of mixtures as required in this Chapter. Asbestos fiber, up to three per cent of weight of cement, may be added to portland cement sand aggregate plaster mix; or approved

TABLE NO. 47-1—ATTACHMENT FOR EXTERIOR PLASTER REINFORCEMENT, STRING WIRES, AND PAPERBACKING

TYPE OF CONSTRUCTION	ATTACHMENTS FOR ¹		
	STRING WIRES 6" APART VERTICALLY	PAPERBACKING ²	REINFORCEMENT (FURRED OUT ¼" MINIMUM) ³
Wood Frame Sheathed	—	Nails or approved staples ⁴	Furring nails, approved staples, or other furring device, 6" apart vertically on supports
Wood Frame Open	32 inches on center horizontally ⁴	Nails or approved staples ⁵	Furring nails, approved staples, or other furring device, 6" apart vertically on supports
Steel Frame Open	—	Clip or other attachment	Clip or other attachment 6" apart vertically on supports
Masonry or Concrete (when reinforcement is used)	—	—	Furring device 6" apart vertically and 16" apart horizontally

¹All nails, staples or other metal attachments of lath and reinforcements shall be corrosion-resistant.

²Paperbacking may be omitted in the following cases [See Section 1707 (a), Building Paper]:

- When exterior covering is of approved weatherproof panels.
- In back-plastered construction.
- When there is no human occupancy.
- Over water-repellant panel sheathing.
- Under approved paperbacked metal or wire fabric lath.
- Under metal lath, wire lath, or wire fabric lath on incombustible construction.

³Self-furring metal lath or self-furring wire fabric lath meets requirements. In addition furring shall not be required on steel members having a flange width of one inch (1") or less.

⁴Attachment for paperbacking shall be of such nature that it will not tear paper.

⁵String wires must be stretched in taut position either by staggering the attachments up and down (herringbone fashion) or by wrapping the wire around the attachments; wires must be securely fastened in place.

portland cement containing asbestos fiber, blended with cement at time of manufacture and with container so labeled may be used. Plasticity agents may be added to standard (Type I) portland cement if approved by the Building Official.

2. **Acoustical and other plaster finishes.** Acoustical plaster, dash plaster coats and other machine textured plaster finishes shall be mixed and handled by machines according to the manufacturer's specifications.

Machine Applied Plaster
(Continued)

**Pneumatically
Placed
Plaster**

Sec. 4713. Pneumatically placed cement plaster shall be a mixture of portland cement and sand, mixed dry, conveyed by air through a pipe or flexible tube, hydrated at the nozzle at the end of the conveyor, and deposited by air pressure in its final position.

Rebound material may be screened and reused as sand in an amount not greater than 25 per cent of the total sand in any batch.

Pneumatically placed cement plaster shall consist of a mixture of one part cement to not more than five parts sand. Plasticity agents may be used as specified in Section 4711 (b). Except when applied to concrete or masonry, such plaster shall be applied in not less than two coats to a minimum total thickness of seven-eighths inch ($\frac{7}{8}$ "). The first coat shall be rodged as specified in Section 4711 (c) for the second coat. The curing period and time interval shall be as set forth in Table No. 47-H.

**Portland
Cement
Plaster**

Sec. 4714. Portland cement plaster not less than one and one-half inches ($1\frac{1}{2}$ ") in thickness reinforced in two directions with not less than 0.3 per cent of steel may be considered to act with the studs to resist bending and shear under horizontal forces when said reinforcement is anchored to the stud in such a manner as to resist effectively the stresses developed. The unit stresses for such reinforced plaster shall be not more than 50 per cent of those allowed for concrete set forth in Table No. 26-B, based on a compressive strength of such plaster of 1500 pounds per square inch.

**Gypsum
Wallboard**

Sec. 4715. Gypsum wallboard shall comply with U.B.C. Standard No. 47-8-64. It shall be securely nailed to framing members as set forth in Table No. 47-J.

EXCEPTIONS: 1. Two nails may be used spaced two inches (2") apart and not more than twelve inches (12") on center at interior supports where no fire-resistive rating is required and the walls are not required as shear walls.

2. In pocket framing for doors an approved adhesive may be used in lieu of nails.

When gypsum wallboard ceiling panels are to be nailed to cross strapping or furring, these members shall have a minimum cross section of two inches by two inches (2" x 2") (nominal).

In single-layer application, all edges and ends of gypsum wallboard shall occur over nailing members, except that this is not required for treated joints at right angles to framing members when the board is applied horizontally.

Wallboard laminating adhesives shall be of approved types and when used for bonding together two or more layers of gypsum wallboard shall be applied in accordance with the adhesive manufacturer's recommendation.

TABLE NO. 47-J—THICKNESS OF WALLBOARD, MAXIMUM SPACING OF SUPPORTS, METHOD OF ATTACHMENT

THICKNESS OF GYPSUM WALLBOARD (Inches)	SIZE AND TYPE OF NAIL	SPACING OF NAILS (Inches)		SPACING OF SUPPORT (Inches)
		Walls	Ceilings	
½	5d 1½ ga. 1⅝" long, ⅜" flat head, diamond-point nail or .098 ga. 1¼" long, ¼" slightly counter-sunk head, medium diamond-point with annular threads slightly tapered, bright, non-coated	6 to 8	5 to 7	16
	1⅝" 13 ga. ⅜" dia. head blued, etched or ringed nail			
⅝	6d 13 ga. 1⅝" long, ¼" flat head, diamond-point nail	6 to 8	5 to 7	16
	1⅝" 13 ga. ⅜" dia. head blued, etched or ringed nail			

NOTE: Spacing of twenty-four inches (24") may be allowed for ceilings where no fire-resistive construction is required. Where framing members exceed sixteen inches (16") on center gypsum wallboard shall be applied with the long dimension of the board at right angles to framing members with all joints covered with joint reinforcing tape and adhesive.

Sec. 4716. Wood stud walls and partitions finished with gypsum wallboard may be used to resist horizontal forces not exceeding those set forth in Table No. 47-K. The four-foot (4') wide wallboard shall be applied horizontally or vertically to wood studs not less than one and five-eighths inches (1⅝") in width, spaced sixteen inches (16") on centers. End

**Gypsum
Wallboard
Diaphragms**

TABLE NO. 47-K—ALLOWABLE SHEARS FOR WIND OR SEISMIC LOADING ON VERTICAL DIAPHRAGMS OF GYPSUM WALLBOARD CONSTRUCTION FOR TYPE V CONSTRUCTION ONLY¹
(Pounds per lineal foot)

THICKNESS AND APPLICATION	NAIL SIZES	SHEAR VALUE	
		7" NAIL SPACING	4" NAIL SPACING
½" without blocking	5d or .098 ga.	100	125
½" with blocking	5d or .098 ga.	125	150

¹Gypsum wallboard diaphragms shall not be used to brace concrete or masonry walls.

**Gypsum
Wallboard
Diaphragms
(Continued)**

joints shall be staggered. Nailing shown in Table No. 47-K shall be provided at the wallboard perimeter, at intermediate studs and at blocking provided behind horizontal joints of the wallboard. Nails shall be spaced not less than three-eighths inch ($\frac{3}{8}$ ") from edges and ends of the wallboard. Nailing at horizontal joints for installation without blocking is not required. Marginal studs of shear walls or shear-resisting elements shall be adequately anchored at top or bottom and designed to resist all forces. The maximum height-width ratio shall be one and one-half to one.

**Gypsum
Sheathing
Board
Diaphragms**

Sec. 4717. Wood stud walls sheathed with gypsum sheathing may be used to resist horizontal forces not exceeding those set forth in Table No. 47-L. The two-foot by eight-foot (2' x 8') sheathing shall be applied horizontally, and the four-foot (4') wide sheathing may be applied horizontally or vertically to wood studs not less than one and five-eighths inches ($1\frac{5}{8}$ ") in width spaced sixteen inches (16") on centers. End joints shall be staggered. Nailing shown in Table No. 47-L shall be provided at the perimeter of the sheathing board, at intermediate studs, and at blocking provided behind horizontal joints of the sheathing board. Nailing at horizontal joints for installation without blocking is not required. Nails shall be spaced not less than three-eighths inch ($\frac{3}{8}$ ") from edges and ends of sheathing.

Marginal studs of shear walls or shear-resisting elements shall be adequately anchored at top or bottom and designed to resist all forces. The maximum height-width ratio shall be one and one-half to one.

**Gypsum
Lath and
Plaster
Diaphragms**

Sec. 4718. Wood stud walls may be used to resist horizontal forces not exceeding those set forth in Table No. 47-M. The shear values are not additive where the material is applied over other types of diaphragms specified in the Code. The gypsum lath shall be applied horizontally to wood studs not less than one and five-eighths inches ($1\frac{5}{8}$ ") in width spaced sixteen inches (16") on centers. End joists shall be

**TABLE NO. 47-L—ALLOWABLE SHEARS FOR WIND OR SEISMIC LOADING
ON VERTICAL DIAPHRAGMS OF GYPSUM SHEATHING BOARD
CONSTRUCTION FOR TYPE V CONSTRUCTION ONLY¹
(Pounds per lineal foot)**

SIZE AND APPLICATION	NAIL SIZE	SHEAR VALUE 4" NAIL SPACING
$\frac{1}{2}$ " x 2' x 8' without blocking	11 ga., $1\frac{3}{4}$ " long $\frac{1}{8}$ " diamond-head gal. nails	75
$\frac{1}{2}$ " x 4' with blocking	11 ga., $1\frac{3}{4}$ " long $\frac{1}{8}$ " diamond-head gal. nails	175

¹Gypsum sheathing board diaphragms shall not be used to brace concrete, masonry or masonry veneered walls.

**TABLE NO. 47-M—ALLOWABLE SHEARS FOR WIND OR SEISMIC LOADING
ON VERTICAL DIAPHRAGMS OF GYPSUM LATH AND PLASTER FOR
TYPE V CONSTRUCTION ONLY¹
(Pounds per lineal foot)**

**Gypsum Lath
and Plaster
Diaphragms
(Continued)**

TYPE OF LATH	SIZE AND SPACING OF NAILS	THICKNESS AND KIND OF PLASTER	SHEAR VALUE
$\frac{3}{8}$ " Plain or Perforated Gypsum Lath	13 ga. $1\frac{1}{8}$ " long, $\frac{1}{8}$ " diamond-head approximately 5" on center	$\frac{1}{2}$ " Gypsum-sand or Gypsum-perlite or Gypsum- Vermiculite	100

¹Gypsum lath and plaster diaphragms shall not be used to brace concrete, masonry or masonry veneered walls.

staggered. Size and spacing of nails shall be as shown in Table No. 47-M. Nails shall be spaced not less than three-eighths inch ($\frac{3}{8}$ ") from edges and ends of gypsum lath. Marginal studs of shear walls or shear-resisting elements shall be adequately anchored at top or bottom and designed to resist all forces. Maximum height-width ratio shall be one and one-half to one.

Gypsum-sand plaster shall be used in the proportion of one part gypsum plaster to two and one-half parts of sand by weight. Gypsum-perlite or gypsum-vermiculite plaster shall be mixed in the proportion of 100 pounds of gypsum plaster to two and one-half cubic feet of perlite or vermiculite. The plaster shall be applied to a total thickness of one-half inch ($\frac{1}{2}$ ") including the finish coat.

PART XI
SPECIAL SUBJECTS

CHAPTER 48—FILM STORAGE

**Film
Storage**

Secs. 4801, 4802, and 4803. Where it is desired to regulate film storage, complete provisions covering handling and storage of photographic and X-ray nitrocellulose films may be found in Appendix Chapter 48.

CHAPTER 49—MECHANICAL REFRIGERATION

Refrigeration

Secs. 4901 and 4902. Where it is desired to regulate the type and installation of mechanical refrigeration, complete provisions may be found in Appendix Chapter 49.

CHAPTER 50—PREFABRICATED CONSTRUCTION

General

Sec. 5001. (a) Purpose. The purpose of this Chapter is to regulate materials and establish methods of safe construction where any structure or portion thereof is wholly or partially prefabricated.

(b) Scope. Unless otherwise specifically stated in this Chapter, all prefabricated construction and all materials used therein shall conform to all the requirements of this Code. (See Section 106.)

(c) Definition. "Prefabricated assembly" is a structural unit, the integral parts of which have been built up or assembled prior to incorporation in the building.

Tests of Materials

Sec. 5002. Every approval of a material not specifically mentioned in this Code shall incorporate as a proviso the kind and number of tests to be made during prefabrication.

Tests of Assemblies

Sec. 5003. The Building Official may require special tests to be made on assemblies to determine their durability and weather resistance.

Connections

Sec. 5004. Every device designed to connect prefabricated assemblies shall be capable of developing the strength of the members connected, except in the case of members forming part of a structural frame designed as specified in Chapter 23. The connection device shall be designed as required by the other Chapters in this Code. Connections between roofs and the supporting walls shall be capable of withstanding an up-lift equal to five pounds per square foot of roof.

Sec. 5005. In structural design, due allowance shall be made for any material to be removed for the installation of pipes, conduits, or other equipment. **Pipes and Conduits**

Sec. 5006. (a) Materials. Materials and the assembly thereof shall be inspected to determine compliance with this Code. Every material shall be grade marked or labeled where required elsewhere in this Code. **Certificate and Inspection**

(b) Certificate. A certificate of approval shall be furnished with every prefabricated assembly, except where the assembly is readily accessible to inspection at the site. The certificate of approval shall certify that the assembly in question has been inspected and meets all the requirements of this Code. When mechanical equipment is installed so that it cannot be inspected at the site, the certificate of approval shall certify that such equipment complies with the laws applying thereto.

(c) Certifying Agency. To be acceptable under this Code, every certificate of approval shall be made by an approved agency.

(d) Field Erection. Placement of prefabricated assemblies at the building site shall be inspected by the Building Official to determine compliance with this Code.

(e) Continuous Inspection. If continuous inspection is required for certain materials where construction takes place on the site, it shall also be required where the same materials are used in prefabricated construction.

EXCEPTION: Continuous inspection will not be required during prefabrication if the approved agency certifies to the construction and furnishes evidence of compliance.

CHAPTER 51—HEAT-PRODUCING APPLIANCES

(See Appendix, Page 430)

CHAPTER 52—PLASTICS

General

Sec. 5201. (a) **Material.** Plastic materials may be of any plastic defined in this Chapter.

(b) **Approval for Use.** The Building Official shall require that sufficient technical data be submitted to substantiate the proposed use of any plastic material and, if it is determined that the evidence submitted is satisfactory for the use intended, he may approve its use subject to the requirements of this Chapter.

(c) **Identification.** Each sheet, roll or piece of plastic for which a building permit is required shall be identified with a mark or decal satisfactory to the Building Official showing its intended use.

Definitions

Sec. 5202. APPROVED PLASTICS. Approved plastic materials shall be those specified in U.B.C. Standard No. 52-1-64 which have a flame-spread rating of 225 or less and a smoke density not greater than that obtained from the burning of untreated wood under similar conditions when tested in accordance with U.B.C. Standard No. 42-1-64 in the way intended for use. The products of combustion shall be no more toxic than the burning of untreated wood under similar conditions.

Installation

Sec. 5203. (a) **General.** All plastics shall be approved plastics and those used as interior finish or trim shall comply with the requirements specified in Chapter 42.

EXCEPTION: Approved plastics are not required to be used in occupancies not restricted by Table No. 42-B.

(b) **Structural Requirements.** All plastic materials and their assemblies shall be of adequate strength and durability to withstand the design loads as prescribed elsewhere in this Code. Sufficient and substantial technical data shall be submitted to the Building Official by an approved testing agency to establish stresses, maximum unsupported spans, and such other information as may be deemed necessary by the Building Official for the various thicknesses and forms used.

(c) **Fastenings.** Fastenings shall be adequate to withstand design loads as prescribed elsewhere in this Code. Proper allowance shall be made for expansion and contraction of plastic materials in accordance with accepted data on coefficient of expansion of the material and any material in conjunction with which it is employed.

**Glazing of
Openings**

Sec. 5204. Doors, sash and framed openings in exterior walls of all buildings except Types I and II construction may be glazed or equipped with approved plastic provided:

1. The wall in which such glazing is installed is so located that openings are not required to be fire-protected.

TABLE NO. 52-A—INSTALLATION OF GLAZED OPENINGS IN ANY ONE EXTERIOR WALL AND ANY ONE STORY¹

Glazing of
Openings
(Continued)

DISTANCE OF EXTERIOR WALL FROM PROPERTY LINE OR WIDTH OF ADJOINING PUBLIC WAY IN FEET	MAXIMUM PER CENT OF EXTERIOR WALL AREA PERMITTED TO BE OF PLASTIC PANELS	MAXIMUM AREA OF INDIVIDUAL PLASTIC PANEL IN SQUARE FEET	MINIMUM SEPARATION BETWEEN PLASTIC PANELS IN FEET	
			Vertical	Horiz.
10-20	10	50	8	4
20-30	20	80	6	3
30-more	30	100	4	2

¹Not permitted in Types I and II buildings.

2. Except for Type V-N buildings, the location, size and spacing of such glazed openings do not exceed the values set forth in Table No. 52-A.

3. Plastics used in glazed openings of Type IV-N buildings are Class I or II materials as set forth in Table No. 42-A and the location, size and spacing of the openings do not exceed the values set forth in Table No. 52-A.

Sec. 5205. (a) General. Regardless of the provisions of Chapter 34, approved plastics may be used in skylights installed on roofs of Type III-N, IV-N or V-N buildings and all buildings equipped with an approved automatic fire-extinguishing system in Groups B-3, B-4, C, F, G, H, 1 and J Occupancies. **Skylights**

EXCEPTIONS: 1. Approved plastics may be used in any type of construction or occupancy as a fire venting system when approved by the Building Official.

2. Plastics may be used in approved skylights in Type V One-Hour constructions which are located twelve inches (12") or more above the lower plane of the ceiling. The walls of the skylight well shall be no less fire-resistive than the adjacent ceiling.

3. Where a fire-resistive ceiling is not required in one-story buildings, approved plastics may be used in skylights.

(b) Installation Requirements. 1. No skylight shall be installed within ten feet (10') of a property line.

2. The edges of dome-type skylights shall be properly flashed.

3. Plastic skylights shall be separated from each other by at least eight feet (8') laterally and ten feet (10') along the slope of the roof.

(c) Allowable Areas. The area of individual plastic skylights shall not exceed one hundred square feet (100 sq. ft.).

The total aggregate area of plastics used in skylights, monitors and sawtooth glazing shall not exceed 20 per cent of the floor area of the room or occupancy sheltered.

**Skylights
(Continued)**

(d) **Curb Requirements.** Plastic skylights in roofs having a slope of less than four in 12 shall have a four-inch (4") high curb.

EXCEPTION: The curb may be omitted where skylights are provided with a screen constructed of wire not smaller than No. 12 U. S. gauge with a mesh not larger than one inch (1") immediately below the skylight. The screen shall be substantially mounted below the skylight.

**Light-Transmitting
Panels in
Monitors and
Sawtooth Roofs**

Sec. 5206. (a) General. Where a fire-resistive rating is not required for the roof structure, and in all buildings provided with an approved automatic fire-extinguishing system, approved plastics may be used with or without sash as the light-transmitting medium in monitors and sawtooth roofs.

EXCEPTION: Plastics used in monitors or sawtooth roofs of Type IV-N buildings shall be of Class I or II material as set forth in Table No. 42-A.

(b) **Allowable Areas.** The area of individual plastic glazing used in monitors and sawtooth glazing shall not exceed one hundred and fifty square feet (150 sq. ft.). The total aggregate area of plastics used in skylights, monitors and sawtooth glazing shall not exceed 20 per cent of the floor area of the room or occupancy sheltered.

(c) **Area Separations.** The areas of such plastic panels shall be separated from each other by a section of incombustible material or by a section of the roofing material of the structure not less than five feet (5') in length. The lower edge of the plastic material shall be at least six inches (6") above the surface of the adjoining roof surface.

**Plastic Light
Diffusers in
Ceilings**

Sec. 5207. (a) General. Ceiling light diffusers having an area greater than 10 per cent of any one hundred square feet (100 sq. ft.) of room area shall be of approved plastics conforming to the requirements specified in Chapter 42.

(b) **Installation.** Plastic light diffusers shall be installed in such a manner that they will not readily become detached when subjected to room temperatures of 300°F. for 25 minutes.

EXCEPTIONS: 1. Plastic light diffusers which are installed in the first floor areas of Group C Occupancies having egress directly to the exterior of the building.

2. Plastic light diffusers which are located between an approved automatic fire-extinguishing system and the areas to be protected other than public corridors or Groups A, B, C, D and E Occupancies if tests by an approved agency have established that such installation will not interfere with the efficient operation of such automatic fire-extinguishing systems.

Sec. 5208. Where partitions are not required to be of fire-resistant or incombustible construction, approved plastics conforming to the requirements specified in Chapter 42 and Section 1705 (a) 3 may be used.

Partitions

Sec. 5209. (a) General. Exterior veneer may be of approved plastic materials and shall conform to the provisions of this Section.

Exterior Veneer

(b) **Height.** Plastic veneer shall not be attached to any exterior wall above the first story.

EXCEPTION: Plastic veneer may be attached to exterior walls above the first story of buildings located outside of Fire Zones No. 1 and No. 2 provided the height of veneer is not in excess of thirty-five feet (35') above the adjacent grade elevation.

(c) **Area.** Sections of plastic veneer shall not exceed one hundred and fifty square feet (150 sq. ft.) in area.

EXCEPTION: In Fire Zone No. 3 the area may be increased by 50 per cent.

(d) **Separation.** Sections of plastic veneer shall be separated by a minimum of four feet (4') vertically and two feet (2') horizontally.

Sec. 5210. Class I and II plastics may be used in awnings and canopies, and all such awnings and canopies shall be constructed in accordance with provisions governing projections and appendages as specified in Section 4506.

Awnings and Canopies

Approved plastics may be used in awnings where untreated canvas is permitted.

Sec. 5211. Approved plastics may be used in lieu of plain glass in greenhouses in Fire Zone No. 3.

Greenhouses

CHAPTER 53—SHEET METAL PAINT SPRAY BOOTHS

General

Sec. 5301. (a) General. Paint spray booths shall be constructed of steel of not less than No. 18 U. S. gauge in thickness and shall be designed in accordance with Section 2722.

(b) **Area.** The area of a paint spray booth shall not exceed fifteen hundred square feet (1500 sq. ft.) nor 10 per cent of the basic area permitted for the major use of the building as set forth in Table No. 5-C.

(c) **Floor Construction.** The floor shall be constructed of incombustible material.

(d) **Interior Surfaces.** Paint spray booths shall be designed to permit the free passage of exhaust air from all parts of the interior and all interior surfaces shall be smooth and continuous without outstanding edges.

Fire Protection

Sec. 5302. Every spray booth having an open front elevation larger in area than nine square feet (9 sq. ft.), and which is not equipped with doors, shall have a fire curtain or metal deflector not less than four inches (4") deep installed at the upper outer edge of the booth opening and shall also be provided with an approved automatic fire-extinguishing sprinkler head for each fifty square feet (50 sq. ft.) of booth roof area.

Interior ducts shall be protected with sprinklers. Such sprinklers shall be installed not more than twelve feet (12') apart in horizontal ducts and shall be accessible through duct access doors.

Light

Sec. 5303. Paint spray booths shall be illuminated through hammered wire or heat-treated glass panels. The glass panels shall be located in such a manner as to reduce the hazard of ignition caused by paint spray deposit.

Ventilation

Sec. 5304. (a) General. Mechanical ventilation shall be provided direct to the exterior of the building. The mechanical exhaust system shall be designed to move the air through any portion of the paint spray area at the rate of not less than 100 lineal feet (100 lin. ft.) per minute. The blades of the exhaust fan shall be constructed of nonferrous material and shall be mounted in such a manner as to prevent contact with the exhaust duct. The motor shall not be mounted in the spray booth or the duct system and belts shall be enclosed where they enter the booth or duct system.

(b) **Exhaust Ducts.** Exhaust ducts shall be constructed of steel having a thickness not less than the values set forth in Table No. 53-A.

The discharge point for ducts in a paint spray booth shall be not less than six feet (6') from adjoining combustible con-

TABLE NO. 53-A—MINIMUM THICKNESS OF EXHAUST DUCTS

Ventilation
(Continued)

DIAMETER OF DUCT (In inches)	MINIMUM THICKNESS (In U. S. Standard Gauge)
8" or less	24
Over 8" to 18" Inclusive	22
Over 18" to 30" Inclusive	20
Over 30"	18

struction nor less than twenty-five feet (25') from adjoining exterior wall openings.

EXCEPTION: The discharge point for exhaust ducts is not regulated in a waterwash spray booth.

Sec. 5305. All electrical equipment shall be installed in accordance with U.B.C. Standard No. 53-1-64. Other sources of-ignition shall also meet the requirements of this Standard.

Electrical
Equipment

CHAPTER 54—GLASS AND GLAZING

Scope

Sec. 5401. All glass and glazing in exterior wall openings and hazardous locations named in Section 5406 shall conform to the regulations specified in this Chapter and U.B.C. Standard No. 54-1-64.

EXCEPTION: Glazing of window openings not regulated in Section 5406 of Groups H and I Occupancies less than four stories in height and Group J Occupancies may be exempted from these provisions.

See Part V of this Code for additional glass requirements where openings are required to be fire protected and Section 5204 for openings glazed with plastics.

Identification

Sec. 5402. Each light shall bear the manufacturer's label designating the type and thickness of glass. Each light with special performance characteristics such as laminated, heat-strengthened, fully tempered, or insulated shall bear the manufacturer's identification showing the special characteristic and thickness by etching or other permanent means, and need not be labeled.

Area Limitations

Sec. 5403. The area of individual lights shall be not more than that set forth in Table No. 54-A as adjusted by Table No. 54-B.

Glazing

Sec. 5404. Lights shall be installed in and completely surrounded by frames with the minimum frame laps and glass edge clearances as set forth in Table No. 54-C.

EXCEPTION: Where firm support is not provided at all edges, the means of installation shall meet the approval of the Building Official.

Louvered Windows

Sec. 5405. Louvered windows may be exempted from the provisions of this Chapter if the individual lights are less than one and one-half square feet ($1\frac{1}{2}$ sq. ft.) in area.

TABLE NO. 54-A—MAXIMUM ALLOWABLE AREAS OF GLASS¹

	SINGLE STRENGTH	DOUBLE STRENGTH						
Glass Thickness (Ins.)	.085" to .100"	0.115" to 0.133"	$\frac{1}{8}$ "	$\frac{1}{8}$ "	$\frac{7}{32}$ "- $\frac{1}{4}$ "	$\frac{5}{16}$ "	$\frac{3}{8}$ "	$\frac{1}{2}$ " and Over
Area ² (Square Feet)	5.8	10.85	12	27	48	75	108	190

¹Areas may be increased for special performance glass having greater strength characteristics if approved by the Building Official.

²Areas shown are for square panes of glass mounted in a vertical position. Glass mounted at a slope not to exceed one horizontal to five vertical may be considered as vertical.

TABLE NO. 54-B—AREA ADJUSTMENT FACTORS FOR
RECTANGULAR SHAPES

RATIO (W/L) ¹	FACTOR (F) ²	RATIO (W/L) ¹	FACTOR (F) ²
1.0	1.00	0.5	.94
0.9	.94	0.4	1.05
0.8	.90	0.3	1.32
0.7	.88	0.2	1.92
0.6	.89	0.1	4.00

¹"W/L" is equal to short side divided by long side.²Factors for intermediate ratios of "W/L" may be obtained by interpolation.

TABLE NO. 54-C—MINIMUM GLAZING REQUIREMENTS

GLASS AREA	FIXED WINDOWS AND OPENABLE WINDOWS OTHER THAN HORIZONTAL SLIDING				
	Up to 6 Sq. Ft.	6 to 14 Sq. Ft.	14 to 32 Sq. Ft.	32 to 50 Sq. Ft.	Over 50 Sq. Ft.
Minimum Frame Lap	1/4 "	1/4 "	5/16 "	3/8 "	1/2 "
Minimum Glass Edge Clearance	1/8 "1,2	1/8 "1,2	3/16 "1	1/4 "1	1/4 "1
Continuous Metal Stop Beads	Required				
Resilient Setting Material	Not Required	Required			
SLIDING DOORS AND HORIZONTAL SLIDING WINDOWS					
GLASS AREA	Up to 14 Sq. Ft.	14 to 32 Sq. Ft.	32 to 50 Sq. Ft.	Over 50 Sq. Ft.	
Minimum Glass Frame Lap	1/4 "	5/16 "	3/8 "	1/2 "	
Minimum Glass Edge Clearance	1/8 "2	3/16 "	1/4 "	1/4 "	
Continuous Metal Stop Beads	Required above third story		Required		
Resilient Setting Material	Not Required		Required		

¹Glass edge clearance in fixed openings shall be not less than that required to provide for wind or earthquake drift.²Glass edge clearance at all sides of pane shall be a minimum of three-sixteenths inch (3/16") where height of glass exceeds three feet (3').

Sec. 5406. Glass lights subject to impact hazards and in **Impact** the following locations shall comply with Table No. 54-D:

1. Glass doors and wall panels of bathtub and shower enclosures. For plastics, see Section 1711 (e).
2. Where bottom of glass light is within eighteen inches (18") of floor or walking surface.
3. Glass lights of glass panel doors.

TABLE NO. 54-D—IMPACT LOADS—GLASS^{1,2}

GLASS TYPE	INDIVIDUAL OPENING AREA	REQUIREMENTS
Regular plate, sheet or rolled (annealed) ³	Over 6 square feet	Not less than $\frac{1}{8}$ " thick. Must be protected by a push-bar or protective screen firmly attached on each exposed side, if not divided by a muntin, or decorated ⁴
Regular plate, sheet or rolled (annealed), surfaced sandblasted, etched, or otherwise depreetiated ³	Over 6 square feet	Not less than $\frac{3}{8}$ " thick. Must be protected by a push-bar or protective screen firmly attached on each exposed side, or decorated ⁴
Regular plate, sheet or rolled (annealed) obscure ³	Over 6 square feet	Not less than $\frac{3}{8}$ " thick. Must be protected by a push-bar or screen firmly attached on each exposed side, or decorated ⁴
Laminated	Over 6 square feet	Not less than $\frac{1}{4}$ " thick
Fully Tempered	Over 6 square feet	Not less than $\frac{3}{8}$ " thick
Wired	Over 6 square feet	Not less than $\frac{1}{4}$ " thick
Frameless All Glass Doors	—	Shall be fully tempered glass

¹Glass less than single strength (SS) in thickness shall not be used.²If short dimension is larger than twenty-four inches (24"), glass must be double strength (DS) or thicker.³Not permitted for bathtub and shower enclosures.⁴Decoration shall be sufficient to make glass plainly visible.

PART XII—LEGISLATIVE**CHAPTER 60—LEGISLATIVE**

Sec. 6001. If any section, subsection, sentence, clause, or phrase of this Ordinance is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this Ordinance. The City Council hereby declares that it would have passed this Ordinance, and each section, subsection, clause, or phrase thereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses, and phrases be declared unconstitutional.

Validity

Sec. 6002. The U.B.C. Standards which are referred to in various parts of this Ordinance shall be the Uniform Building Code Standards, 1964 Edition, and are hereby declared to be a part of this Ordinance.

**Uniform
Building
Code
Standards**

U.B.C. STD. AND SEC. NO.	TITLE AND SOURCE
CHAPTER 4	
4- 1-64 410	Incombustible Material—Tests. Standard Specifications E136 of the A.S.T.M.*
CHAPTER 6	
6- 1-64 608	Proscenium Curtains. Recommended Standards of International Conference of Building Officials.
CHAPTER 9	
9- 1-64 908	Flammable Liquids. National Board of Fire Underwriters Pamphlet 30.
CHAPTER 10	
10- 1-64 1001	Class III Dry Cleaning Systems. Pamphlet 32—Dry Cleaning Plants. National Board of Fire Underwriters.
10- 2-64 1008	Blower and Exhaust System for Dust, Stock and Vapor Control. National Board of Fire Underwriters Pamphlet 91.
CHAPTER 22	
22- 1-64 2202	Fiberboard; Insulating. Federal Specifications LLL-F-321b.
22- 2-64 2202	Gypsum Sheathing Board. Standard Specifications C79 of the A.S.T.M.
CHAPTER 24	
24- 1-64 2403	Building Brick (Made from Clay or Shale). Standard Specifications C62 of the A.S.T.M.
24- 2-64 2403	Sand-Lime Building Brick. Standard Specifications C73 of the A.S.T.M.
24- 3-64 2403	Concrete Building Brick. Standard Specifications C55 of the A.S.T.M.

*A.S.T.M. refers to American Society for Testing Materials.

**Uniform
Building
Code
Standards
(Continued)**

U.B.C. STD. AND SEC. NO.	TITLE AND SOURCE
24- 4-64 2403	Hollow Load-Bearing Concrete Masonry Units. Standard Specifications C90 of the A.S.T.M.
24- 5-64 2403	Solid Load-Bearing Concrete Masonry Units. Standard Specifications C145 of the A.S.T.M.
24- 6-64 2403	Hollow Nonload-Bearing Concrete Masonry Units. Standard Specifications C129 of the A.S.T.M.
24- 7-64 2403	Method of Test for Concrete Masonry Units. Standard Specifications C140 of the A.S.T.M.
24- 8-64 2403	Structural Clay Load-Bearing Wall Tile. Standard Specifications C34 of the A.S.T.M.
24- 9-64 2403	Structural Clay Nonload-Bearing Tile. Standard Specifications C56 of the A.S.T.M.
24-10-64 2403	Structural Clay Floor Tile. Standard Specifications C57 of the A.S.T.M.
24-11-64 2403	Gypsum Partition Tile or Block. Standard Specifications C52 of the A.S.T.M.
24-12-64 2403	Gypsum. Standard Specifications C22 of the A.S.T.M.
24-13-64 2403	Reinforced Gypsum Concrete and Precast Reinforced Gypsum Slabs. Standard Specifications C317 and C377 of the A.S.T.M.
24-14-64 2403	Cast Stone. Specification ACI 704 of the American Concrete Institute.
24-15-64 2403	Joint Reinforcement. Standard Specifications A82 of the A.S.T.M.
24-16-64 2403	Air-Entraining Portland Cement. Standard Specifications C175 of the A.S.T.M.
24-17-64 2403	Cement, Masonry. Standard Specifications C91 of the A.S.T.M.
24-18-64 2403	Quicklime for Structural Purposes. Standard Specifications C5 of the A.S.T.M.
24-19-64 2403	Hydrated Lime for Masonry Purposes. Standard Specifications C207 of the A.S.T.M.
24-20-64 2403	Processed Pulverized Quicklime. Standard Specifications C51 of the A.S.T.M.
24-21-64 2403	Mortar for Masonry Other than Gypsum. Tentative Specifications C161 and C270 of the A.S.T.M.
24-22-64 2403	Aggregate for Masonry Mortar. Tentative Specifications C144 of the A.S.T.M.
24-23-64 2403	Field Tests for Grout and Mortar. Recommended Standards of International Conference of Building Officials.
24-24-64 2403	Aggregates for Grout. Standard Specifications C404 of the A.S.T.M.
24-25-64 2405	Sampling and Testing Brick. Standard Methods C67 of the A.S.T.M.
24-26-64 2407	Testing Gypsum and Gypsum Products. Standard Specifications C26 of the A.S.T.M.

U.B.C. STD. AND SEC. NO.	TITLE AND SOURCE	Uniform Building Code Standards (Continued)
CHAPTER 25		
25- 1-64 2502	Guide to the Grading of All Species of Lumber and Determination of Working Stresses. Tentative Specification D245 of the A.S.T.M.; Simplified Practice Recommendation 16-53 of the U. S. Department of Commerce Bureau of Standards; and Standard Grading Rules of Various Associations.	
25- 2-64 2501	Cypress—Tidewater Red. Standard Specification, Southern Cypress Manufacturers' Association.	
25- 3-64 2501	Douglas Fir, Coast Region, Hemlock, West Coast, and Spruce, Sitka. Grading and Dressing Rules No. 15, West Coast Lumbermen's Association.	
25- 4-64 2501	Douglas Fir, (Western Pine Region): Cedar, Incense and Western Red; Fir, White; Hemlock, Western; Larch; and Spruce, Engelmann. Grading Rules Western Pine Association.	
25- 5-64 2501	Hemlock, Eastern; and Pine, Norway. Grading Rules, Northern Hardwood and Pine Manufacturers Association.	
25- 6-64 2502	Pine, Southern. Grading Rules, Southern Pine Inspection Bureau.	
25- 7-64 2502	Redwood. Specifications of the California Redwood Inspection Service.	
25- 8-64 2502	Spruce, Eastern; and Fir, Balsam. Grading Rules, Northeastern Lumber Manufacturers Association, Inc.	
25- 9-64 2501	Plywood—Douglas Fir and Western Softwood. Commercial Standards CS45 and CS122 of the U. S. Department of Commerce, Bureau of Standards.	
25-10-64 2501	Structural Glued-Laminated Wood—All Species of Lumber. Technical Bulletin 1069, Forest Products Laboratory, U. S. Department of Agriculture.	
25-11-64 2501	Structural Glued-Laminated Wood—Douglas Fir; Southern Pine, Hardwood, West Coast Hemlock, and Larch. Standard Specifications for Design and Fabrication of Structural Glued-Laminated Lumber, West Coast Lumbermen's Association; Structural Glued-Laminated Southern Pine Lumber, Southern Pine Association, and Design and Fabrication of Hardwood Glued-Laminated Lumber.	
25-12-64 2501	Preservative Treatment of Piles by Pressure Processes. Standard Specifications C1, C2, C3, C4, C9 and C12, American Wood Preservers Institute.	
25-13-64 2501	Wood Poles. Specifications and Dimensions for Wood Poles, American Standards Association.	
25-14-64 2501	Round Timber Piles. Standard Specifications D25 of the A.S.T.M.	

**Uniform
Building
Code
Standards
(Continued)**

U.B.C. STD. AND SEC. NO.	TITLE AND SOURCE
25-15-64 2501	Spaced Columns. National Design Specification for Stress-Grade Lumber and Fastenings, National Lumber Manufacturers Association.
25-16-64 2501	Flexural and Axial Loading. National Design Specification for Stress-Grade Lumber and Fastenings, National Lumber Manufacturers Association.
25-17-64 2501	Timber Connectors, Bolts, Drift Bolts and Wood Screws, Lag Screws. Parts V, VI, VII and VIII, National Design Specification for Stress-Grade Lumber and its Fastenings, National Lumber Manufacturers Association.
25-18-64 2511	Flat Panels with Stressed Coverings. Pamphlet 1220, Forest Products Laboratory, U. S. Department of Agriculture.
25-19-64 2511	Adhesives. Specification C-G-456, U. S. Federal Government. Joint Military Specification MIL-A-397B, U. S. Federal Government. Joint Military Specification MIL-A-5534A, U. S. Federal Government.
25-20-64 2511	Test for Glue Joints. Standard Method of Testing D1101 of the A.S.T.M.
25-21-64 2511	General Design Criteria. Recommended Standards of International Conference of Building Officials.
25-22-64 2511	Plank and Beam Construction. Wood Utilization Data No. 4, National Lumber Manufacturers Association.

CHAPTER 26

26- 1-64 2601	Portland Cement. Standard Specifications C150 of the A.S.T.M.
26- 2-64 2601	Portland Blast Furnace Slag Cement. Tentative Specifications C205 of the A.S.T.M.
26- 3-64 2601	Portland Pozzolan Cement. Tentative Specifications C340 of the A.S.T.M.
26- 4-64 2601	Concrete Aggregates. Standard Specifications C33 of the A.S.T.M.
26- 5-64 2601	Lightweight Aggregates for Structural and Insulating Concrete. Tentative Specifications C330 and C332 of the A.S.T.M.
26- 6-64 2601	Steel Bars—Metal Reinforcement. Tentative Specifications A15, A16, A82, A160 and A305 of the A.S.T.M.
26- 7-64 2601	Prestressed Steel Strand. Tentative Specifications A416 of the A.S.T.M.
26- 8-64 2601	Prestressed Steel Wire. Tentative Specifications A421 of the A.S.T.M.
26- 9-64 2601	Air-Entraining Admixtures. Tentative Specifications C260 of the A.S.T.M.
26-10-64 2601	Concrete Compression and Flexure Test Specimens in the Field. Standard Method C31, C39 and C192 of the A.S.T.M.

U.B.C. STD. AND SEC. NO.	TITLE AND SOURCE	Uniform Building Code Standards (Continued)
26-11-64 2601	Ready-Mixed Concrete. Standard Specifications C94 of the A.S.T.M.	
26-12-64 2611	Ultimate Strength Design. A.C.I. Building Code Requirements for Reinforced Concrete (ACI 318).	
26-13-64 2611	Prestressed Design. Recommended Standards of the International Conference of Building Officials.	
26-14-64 2611	Slabs. American Concrete Institute Building Code Requirements for Reinforced Concrete (ACI 318).	

CHAPTER 27

27- 1-64 2701	Material Specifications for Structural Steel. Tentative Specifications of the A.S.T.M.
27- 2-64 2701	Erection, Fabrication, Identification and Painting. Specifications of American Institute of Steel Construction.
27- 3-64 2701	Stress Variation or Stress Reversal Design. Specifications of American Institute of Steel Construction.
27- 4-64 2701	Open Web Steel Joist Design. Specifications of American Institute of Steel Construction.
27- 5-64 2701	Structural Rivet Steel. Standard Specification A141 of the A.S.T.M.
27- 6-64 2701	Welding. Standard Code for Arc and Gas Welding of the American Welding Society.
27- 7-64 2701	High Strength Steel Bolts. Specifications of the American Institute of Steel Construction.
27- 8-64 2701	Composite Design. Specifications of American Institute of Steel Construction.
27- 9-64 2701	Heavy, Light Gauge Structural Quality Flat Hot-Rolled Carbon-Steel Sheets. Tentative Specifications A245 and A303 of the A.S.T.M.
27-10-64 2701	Design of Light Gauge Steel Structural Members. Specification of the American Iron and Steel Institute.

CHAPTER 30

30- 1-64 3004	Dampers. Pamphlet 90A, National Board of Fire Underwriters.

CHAPTER 32

32- 1-64 3203	Composition Roofing. Standard Specifications 55-A, Underwriters' Laboratories, Inc.
32- 2-64 3203	Roofing Asphalt. Standard Specifications D312 of the A.S.T.M.
32- 3-64 3203	Composition Roofing. Standard Specifications 55-B, Underwriters' Laboratories, Inc.
32- 4-64 3203	Sheet Metals. Standard Specifications A245, A361 and B209 of the A.S.T.M.
32- 5-64 3203	Roofing Aggregates. Recommended Standards of International Conference of Building Officials.
32- 6-64 3203	Corrosion-Resistant Metals. Standard Specifications A219 and A239 of the A.S.T.M.

Uniform
Building
Code
Standards
(Continued)

U.B.C. STD. AND SEC. NO.	TITLE AND SOURCE
32- 7-64 3203	Composition Roofing Testing. Standard Specifications 790, Underwriters' Laboratories, Inc.
32- 8-64 3203	Hand-Split Shakes. Grading and Shake Rules, Hand-Split Cedar Shakes, Red Cedar Shake Bureau.
32- 9-64 3203	Asbestos-Cement Shingles. Standard Specifications C222 of the A.S.T.M.
32-10-64 3203	Slate Shingles. Standard Specifications C406 of the A.S.T.M.
32-11-64 3203	Wood Shingles. Commercial Standards CS31, U. S. Department of Commerce, Bureau of Standards.
32-12-64 3203	Roofing Tile. Recommended Standards of International Conference of Building Officials.
32-13-64 3203	Wire. Standard Specifications B134, B149, B211 and B356 of the A.S.T.M.

CHAPTER 37

- 37-1-64 Fire Clay Refractories. Standard Specifications C27 of
3701 the A.S.T.M.

CHAPTER 38

- 38- 1-64 Automatic Fire-Extinguishing Systems. Pamphlet 13,
3802 National Board of Fire Underwriters.
38- 2-64 Carbon Dioxide Fire-Extinguishing Systems. Pamphlet
3802 12, National Board of Fire Underwriters.

CHAPTER 42

- 42- 1-64 Test Method for Fire Hazard Classification of Building
4202 Material. Standard Test Method, Subject 723, Underwriters' Laboratories, Inc.

CHAPTER 43

- 43- 1-64 Fire Tests of Building Construction and Materials.
4302 Standard Methods E119 of the A.S.T.M.
43- 2-64 Fire Tests of Door Assemblies. Standard Methods EI52
4306 of the A.S.T.M.
43- 3-64 Tin-Clad Fire Doors and Shutters. Standard Subject
4306 10 (A), Underwriters' Laboratories, Inc.
43- 4-64 Protection of Openings in Walls and Partitions Against
4306 Fire. Pamphlet 80, National Board of Fire Underwriters.

CHAPTER 47

- 47- 1-64 Inorganic Aggregates for Interior Plaster. Standard
4702 Specifications C35 of the A.S.T.M.
47- 2-64 Gypsum Plasters. Standard Specifications C28 of the
4702 A.S.T.M.
47- 3-64 Special Finishing Hydrated Lime. Standard Specifications C206 of the A.S.T.M.
4702
47- 4-64 Keene's Cement. Standard Specifications C61 of the
4702 A.S.T.M.

U.B.C. STD. AND SEC. NO.	TITLE AND SOURCE	Uniform Building Code Standards (Continued)
47- 5-64 4702	Wood Lath. Standard Specifications for Gypsum Plastering (A42.4) of the American Standards Association.	
47- 6-64 4702	Gypsum Lath. Standard Specifications C37 of the A.S.T.M.	
47- 7-64 4702	Metal and Wire Lath. Standard Specifications for Gypsum Plastering (A42.4) of the American Standards Association.	
47- 8-64 4702	Gypsum Wallboard. Standard Specifications C36 of the A.S.T.M.	

CHAPTER 48

- 48- 1-64
4802 Storage and Handling of Photographic and X-Ray Nitrocellulose Films. Pamphlet 41 of the National Board of Fire Underwriters.
- 48- 2-64
4803 Nitrocellulose Motion Picture Film. Pamphlet 40, National Board of Fire Underwriters.

CHAPTER 49

- 49- 1-64
4901 Mechanical Refrigeration. Standard Safety Code (15), American Society of Refrigerating Engineers.

CHAPTER 52

- 52- 1-64
5202 Technical Data on Plastics. Specifications of the Manufacturing Chemists Association.

CHAPTER 53

- 53- 1-64
5305 Electrical Equipment. Standard for Spray Finishing Using Flammable Materials (Code 33) of the National Fire Protection Association.

CHAPTER 54

- 54- 1-64
5401 Glass. Federal Specification DD-G-451 (a) 1.

CHAPTER 70

- 70- 1-64
7012 Soil Compaction. Standard Specifications D698 of the A.S.T.M.
- 70- 2-64
7012 Field Density of Soil. Recommended Standards of International Conference of Building Officials.

Sec. 6003. Ordinance No.....and all ordinances amendatory thereto, and all ordinances or parts of ordinances in conflict with this Ordinance are hereby repealed. **Ordinances Repeated**

Sec. 6004. This Ordinance shall be, and is hereby declared to be in full force and effect, from and after 30 days from its date of final passage and approval. **Date Effective**

APPENDIX

CHAPTER 13—EXISTING BUILDINGS

Existing
Buildings

Sec. 1309. (a) Purpose. The purpose of this Section is to provide a reasonable degree of safety to persons living and sleeping in apartment houses and hotels through providing for alterations to such existing buildings as do not conform with the minimum safety requirements of this Code.

(b) Scope. The provisions of this Section shall apply exclusively to existing nonconforming Group H Occupancies more than two stories in height.

(c) Effective Date. Eighteen months after the effective date of this Section, every building falling within its scope shall be vacated until made to conform to the requirements of this Section.

(d) Number of Exits. Every apartment and every other sleeping room shall have access to not less than two exits. A fire escape as specified herein may be used as one required exit.

(e) Stair Construction. All stairs shall have a minimum run of nine inches (9") and a maximum rise of eight inches (8") and a minimum width exclusive of handrails of thirty inches (30"). Every stairway shall have at least one handrail. A landing having a minimum horizontal dimension of thirty inches (30") shall be provided at each point of access to the stairway.

(f) Interior Stairways. Every interior stairway shall be enclosed with walls of not less than one-hour fire-resistive construction.

Where existing partitions form part of a stairwell enclosure, wood lath and plaster in good condition will be acceptable in lieu of one-hour fire-resistive construction. Doors to such enclosures shall be protected by a self-closing door equivalent to a solid wood door not less than one and three-fourths inches (1¾") thick. Enclosures shall include landings between flights and any corridors, passageways, or public rooms necessary for continuous exit to the exterior of the building.

The stairway need not be enclosed in a continuous shaft if cut off at each story by the fire-resistive construction required by this Subsection for stairwell enclosures.

Enclosures shall not be required if an automatic fire-extinguishing system is provided for all portions of the building except bedrooms, apartments, and rooms accessory thereto.

(g) Exterior Stairways. Exterior stairs shall be incombustible or of wood of not less than two-inch (2") nominal thickness with solid treads and risers.

Existing
Buildings
(Continued)

(h) **Fire Escapes.** Fire escapes may be used as one means of egress, if the pitch does not exceed 60 degrees, the width is not less than eighteen inches (18"), the treads are not less than four inches (4") wide, and they extend to the ground or are provided with counterbalanced stairs reaching to the ground. Access shall be by an opening having a minimum dimension of twenty-nine inches (29") when open. The sill shall be not more than thirty inches (30") above the floor and landing.

(i) **Doors and Openings.** Exit doors shall swing in the direction of exit travel, shall be self-closing, and shall be operable from the inside without the use of key or any special knowledge or effort. Doors shall not reduce the required width of stairway more than six inches (6") when open. Transoms, and openings other than doors, from corridors to rooms shall be fixed closed and shall be covered with a minimum of three-fourths-inch ($\frac{3}{4}$ ") plywood.

(j) **Exit Signs.** Every exit doorway or change of direction of a corridor shall be marked with a well-lighted exit sign having letters at least five inches (5") high.

(k) **Enclosure of Vertical Openings.** Elevators, shafts, ducts, and other vertical openings shall be enclosed as required for stairways in Subsection (f) or by wired glass set in metal frames. Doors shall be incombustible, or as regulated in Subsection (f).

(l) **Separation of Occupancies.** Occupancy separations shall be provided as specified in Section 503. Lobbies, and public dining rooms not including cocktail lounges, shall not require a separation if the kitchen is so separated from the dining room. Boiler rooms or heater rooms containing a central heating plant using solid or liquid fuel shall be separated from the rest of the building by a Three-Hour Fire-Resistive Occupancy Separation as specified in Chapter 5.

(m) **Alternates.** No alternate method of obtaining the fire protection and safety required by this Section may be used unless the Board of Appeals, including as a voting member for this purpose the Chief of the Fire Department, finds that such alternate method provides protection and safety equivalent to that required herein.

CHAPTER 23

Refer to Sec. 2301.

WEIGHTS OF BUILDING MATERIALS

MATERIAL	LBS. PER CU. FT.	Weights of Building Materials
BRICK—		
Common	125	
Common, laid $\frac{3}{8}$ " joints	120	
Pressed	150	
Soft, laid $\frac{3}{8}$ " joints	100	

**Weights of
Building
Materials
(Continued)**

MATERIAL		LBS. PER CU. FT.
CAST IRON.....		450
CINDERS, DRY, BITUMINOUS, IN BULK.....		45
CONCRETE—		
Cinder, structural		110
Stone or gravel		144
Concrete building tile, 60 per cent solid		87
Concrete building tile, 55 per cent solid		79
EARTH—		
Common loam, dry and loose		76
Clay and gravel, dry and loose		100
Common earth, dry and packed		100
Wet mud		120
GLASS.....		157
GRANITE.....		170
GRANITE MASONRY, DRESSED.....		165
GRANITE MASONRY, RUBBLE.....		155
GRAVEL, DRY.....		120
LIMESTONE MASONRY, DRESSED.....		162
MARBLE MASONRY, DRESSED.....		170
MORTAR, HARD, CEMENT.....		135
MORTAR, HARD, LIME.....		105
SAND, DRY.....		100
SAND, WET.....		120
SLAG (BLAST FURNACE).....		130
STEEL.....		490
TERRA COTTA, FILLED WITH BRICKWORK.....		120
TERRA COTTA, DENNISON INTERLOCK TILE, LAID.....		65
TIMBER—		
Fir, dry		32
Fir, wet		44
Oak		46
WATER, FRESH AT 60°F.....		62.5

MATERIAL		LBS. PER SQ. FT.
CEILINGS—		
Wood, lath and plaster		8
Metal lath and plaster suspended		10
PARTITIONS—		
2" x 4" studs, plaster board, $\frac{5}{8}$ " plaster, both sides		16
2" x 4" studs, wood lath, $\frac{5}{8}$ " plaster, both sides		16
Channel studs, metal lath, cement plaster, solid 2" thick		20
PLASTER ON HOLLOW CLAY TILE (ONE SIDE).....		5
2" hollow clay tile		13
3" hollow clay tile		16
4" hollow clay tile		18
5" hollow clay tile		20
6" hollow clay tile		25
8" hollow clay tile		30
12" hollow clay tile		45

MATERIAL	LBS. PER SQ. FT.	Weights of Building Materials (Continued)
PLASTER ON PLASTER-BLOCK PARTITIONS (ONE SIDE).....	5	
2" plaster blocks	7	
2½" plaster blocks	8.5	
3" plaster blocks	9.5	
3½" plaster blocks	10.5	
4" plaster blocks	12	
5" plaster blocks	15	
6" plaster blocks	18	
8" plaster blocks	22	

ROOFINGS—

Wood shingles	3	
Slate 1½"	7	
Slate ¼"	10	
Tile and clay shingles	11 to 14	
Roman tile, clay	12	
Spanish tile, clay	19	
Ludowici tile, Spanish	10	
Tile roof laid in mortar, add	10	
Copper (if no weight is specified).....	1.5	
Tin	1	
Corrugated iron	2	
Tar and gravel	6	
Prepared composition	1	
Skylights, metal-covered, wire glass	5	

CHAPTER 48—PHOTOGRAPHIC AND X-RAY FILMS

Refer to Chapter 48. The following provisions are recommended for inclusion in the Code where provisions covering the handling and storage of photographic and X-ray nitrocellulose films are desired:

**Photographic
and X-ray
Films**

Sec. 4801. The provisions of this Chapter do not apply to:

**Classes of
Film
Excepted**

1. Film for amateur photographic use in original packages of "roll" and "film pack" films in quantities of less than 50 cubic feet.

2. Safety film (cellulose acetate base).

3. Dental X-ray film.

4. Establishments manufacturing photographic films and storage incidental thereto.

5. Films stored or being used in standard motion picture booths (see Chapter 40).

Safety photographic and X-ray film (cellulose acetate base) may be identified by the marking on the edge of the film. This marking shows plainly before and after developing. Where film is not so marked it shall be inspected to determine whether it is of the safety acetate or nitrate type.

Sec. 4802. All regulations for the storage and handling of photographic and X-ray nitrocellulose films shall conform to the requirements set forth in U.B.C. Standard No. 48-1-64.

**General
Regulations**

EXCEPTION: Where definite fire-resistive materials are specified, materials of equal fire resistance as specified in this Code may be used.

**Motion
Picture
Film**

Sec. 4803. The storage and handling of nitrocellulose motion picture film shall conform to the requirements set forth in U.B.C. Standard No. 48-2-64.

CHAPTER 49—REFRIGERATION SYSTEMS

**Refrigeration
Systems**

Refer to Chapter 49. Where it is desired to regulate the installation or alteration of refrigeration systems, the following provisions are recommended for inclusion in the Code:

General

Sec. 4901. It shall be unlawful for any person, firm, or corporation to install or alter or cause to be installed or altered, any system of refrigeration, unless such system is an approved type and is installed in accordance with the provisions set forth in U.B.C. Standard No. 49-1-64.

Scope

Sec. 4902. Regulations of this Chapter shall apply to all refrigeration systems hereafter installed and to alterations of and additions to such existing systems.

CHAPTER 51—HEAT-PRODUCING APPLIANCES

**Construction,
Installation and
Performance
Requirements**

Sec. 5101. (a) General. Heat-producing appliances shall conform to the requirements of this Chapter.

(b) Definitions. **CIRCULATING SPACE HEATER** is a space heater designed to convert the energy in fuel gas to convected heat, or radiant heat and convected heat, by the circulation of the products of combustion and room air, or room air only.

RADIANT HEATER is a space heater designed primarily to convert the energy in fuel gas to radiant heat.

RECESSED WALL HEATER is a space heater designed for installation within a wall or partition and approved for such use.

ROOM HEATING STOVE is a factory built, solid fuel burning, metal stove used for heating the room in which it is located.

STEAM RADIATOR is a space heater in which all the energy in the fuel gas (with the exception of that lost from the flue by radiation or convection from the combustion chamber) is transmitted to the surrounding atmosphere through the medium of steam or hot water generated within the appliance. In this definition, the combustion chamber is that part of the appliance in which combustion of the gas takes place and does not include the flue passages.

UNIT HEATER—LOW STATIC PRESSURE TYPE is a self-contained, automatically controlled, vented, gas-burning appliance, limited to the heating of nonresidential space in which it is installed. Such appliances shall have integral means for circulation of air, normally by a propeller fan or fans, and may be equipped with louvers or face extensions made in accordance with the manufacturer's approved specifications.

**Construction,
Installation and
Performance
Requirements
(Continued)**

UNIT HEATER—HIGH STATIC PRESSURE TYPE is a self-contained, automatically controlled, vented, gas-burning appliance, limited to the heating of nonresidential space. Such appliances have integral means for circulation of air against two-tenths inch (2/10") or greater static pressure and are designed for installation in the space to be heated unless they are equipped with provisions for attaching both inlet and outlet air ducts.

(c) **Approvals.** Each heat-producing appliance and accessory shall be of a type complying with applicable nationally recognized standards as determined by an approved testing agency.

Where no such standards exist, approval of the Building Official shall be obtained before the appliance or accessory is installed.

(d) **Installation.** The installation of heat-producing appliances covered by this Chapter shall conform to the conditions of approval as specified in the manufacturer's instructions pertaining to safety and to the requirements of this Chapter. The installer shall leave the manufacturer's instructions attached to the appliance for examination by the Building Official.

Appliances installed in garages, warehouses or other areas where they may be subjected to mechanical damage shall be suitably guarded against such damage by being installed behind protective barriers or by being elevated or located out of the normal path of vehicles.

Appliances generating a glow, spark, or flame capable of igniting flammable vapors may be installed in a garage provided the pilots and burners, or heating elements and switches are at least twenty-four inches (24") above the floor level.

Where such appliances installed within a garage are enclosed in a separate, approved compartment having access only from outside of the garage such appliances may be installed at floor level provided the required combustion air is taken from and discharged to the exterior of the garage.

Fuel-burning appliances having sealed combustion chambers and which are so constructed and installed that all air for combustion and ventilation is taken from outside the garage area and all flue gases are discharged to the outside atmosphere may be installed at floor level.

(e) **Fuel Connections.** Requirements shall be as follows:

1. All gas and liquid fuel-burning heat-producing appli-

**Construction,
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Requirements
(Continued)**

ances shall be rigidly connected to the fuel piping outlet with standard I.P.S. (iron pipe size) pipe, except as hereinafter provided.

2. Before any additional fuel connections may be made to existing fuel supply lines, pipe sizes shall be approved by the Building Official. If such piping is found to be inadequate, separate or adequate fuel lines shall be installed from the source to the heating appliance.

3. Type K semirigid seamless copper tubing may be used to connect any oil-burning appliance to the source of fuel supply. The maximum length of such tubing shall be three feet (3') and shall be of an approved type. The capacity of such tubing shall be that required by the appliance. Such tubing shall not be concealed in, or pass through, any wall, floor, or partition.

4. Gas appliances burning not more than 100,000 B.t.u.'s per hour may be connected with approved metal appliance connectors complying with the following requirements:

No portion of such connector shall extend through, or be concealed in any wall, partition, door, floor, or ceiling.

Such connector shall be not less than two inches (2") from masonry or concrete, or six inches (6") from earth.

Such connectors shall have a nominal diameter not less than that of the inlet connection to the appliance as provided by the manufacturer of the appliance, except that gas appliances burning not more than 40,000 B.t.u.'s per hour may be connected with approved metal tubing connectors having a nominal diameter of three-eighths inch ($\frac{3}{8}$ ") and an over-all length not to exceed eighteen inches (18").

5. An accessible approved type shutoff cock shall be installed in the fuel piping outside of each appliance and ahead of the union connection thereto, in addition to any valve on the appliance. Such shutoff cock shall be of the same size as the fuel supply line to the appliance and have a fuel passageway equivalent in area to the appliance tubing connector.

Such shutoff cock shall be within three feet (3') of the appliance, except for range connectors.

EXCEPTION: Shutoff valves may be accessibly located inside or under an appliance when such appliance can be removed without removal of the gas shutoff valve.

6. All electrical connections and wiring shall be made in accordance with the electrical code. This requirement shall not apply to enclosed wiring which is an integral part of any approved electrically controlled device. Gas piping shall not be used for an electrical ground or in lieu of wiring.

(f) **Clearances.** Clearances of heat-producing appliances from combustible material shall be as specified in this Chapter or as set forth in Table No. 51-A or 51-B.

(g) **Weather Protection.** Unless approved for outdoor installation, appliances shall be installed within a building or adequately protected against the weather.

Sec. 5102. (a) General. All fuel-burning appliances shall be assured a sufficient supply of fresh air for proper fuel combustion and ventilation of the appliance enclosure.

**Fresh-Air Supply
for Combustion
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(b) **Space.** Provisions shall be made to supply fresh air to the space in which fuel-burning appliances are located if the volume in cubic feet of this space is less than:

1. One-twentieth of the maximum rated input in B.t.u.'s of all gas-burning appliances other than listed ranges, hot plates and refrigerators in such space.

2. One-tenth of the maximum rated input in B.t.u.'s of all appliances burning solid and liquid fuel in such space.

(c) **Methods of Supplying Fresh Air.** Where provisions for fresh air are required in this Section, one of the following methods shall be used:

1. Permanent openings or ducts leading from the appliance location to other interior areas, except unventilated attics, which meet the minimum required volume specified in Subsection (b). Such openings or ducts shall be not less in size than those specified in Subsection (c) 2.

2. Permanent openings or ducts leading from the appliance enclosure to the outside of the building.

For gas-burning appliances, such openings or ducts shall have unobstructed areas not less than as set forth in Table No. 51-C and in no case less than one hundred square inches (100 sq. in.).

EXCEPTION: Combustion air supply for gas-burning appliances having a total B.t.u. input rating in excess of 500,000 B.t.u.'s per hour may be designed in accordance with recognized engineering principles when first approved by the Building Official.

For appliances burning solid or liquid fuels the required areas shall be one and one-half times those required for gas-burning appliances.

An unobstructed space across the entire front of the appliance and not less than six inches (6") in depth, shall extend from the floor to at least the top of the appliance. Both top and bottom combustion air openings shall extend full size to the firebox opening and to the draft hood.

-Where openings or ducts are used, at least half of such opening shall be through an opening, the top of which shall extend to within six inches (6") of the ceiling, and at least one-half of such opening shall be through an opening the bottom of which shall extend to within six inches (6") of the floor and shall be constructed of incombustible material not less than six inches (6") in the least dimension.

(Continued on page 439)

TABLE NO. 51-A—STANDARD INSTALLATION CLEARANCES FOR HEAT-PRODUCING APPLIANCES¹

These clearances apply unless otherwise shown on listed appliances. Appliances shall not be installed in alcoves or closets unless so listed.
Installation on combustible floors.²

RESIDENTIAL TYPE APPLIANCES For Installation in Rooms Which Are Large ¹		APPLIANCE					CHIMNEY CONNECTOR (Inches)	VENT CON- NECTOR ⁵ (Inches)
		Above Top of Casing or Appliance (Inches)	From Top and Sides of Warm-Air Bonnet or Plenum (Inches)	From Front ⁴ (Inches)	From Back (Inches)	From Sides (Inches)		
BOILERS AND WATER HEATERS ²		FUEL						
Steam Boilers—15 p.s.i. Water Boilers—250°F. Water Heaters—200°F. All Water Walled or Jacketed	Automatic Oil or Combination Gas and Oil	6	—	24	6	6	18	—
	Automatic Gas	6	—	18	6	6	—	9
	Solid	6	—	48	6	6	18	—
FURNACES—CENTRAL								
Gravity Upflow, Downflow, Horizontal and duct Warm Air—250°F. maximum Limit Control	Automatic Oil or Combination Gas and Oil	6 ⁶	6 ⁶	24	6	6	18	—
	Automatic Gas	6 ⁶	6 ⁶	18	6	6	—	9
	Solid	18 ⁷	18 ⁷	48	18	18	18	—
	Electric	6 ⁶	6 ⁶	18	6	6	—	—
FURNACES—FLOOR								
For Mounting in Combusti- ble Floors Floors	Automatic Oil or Combination Gas and Oil	36	—	12	12	12	18	—
	Automatic Gas	36	—	12	12	12	—	9

HEAT EXCHANGER, SUPPLIED FROM A REMOTE SOURCE									
Steam--15 p.s.i. maximum		1	1	1	1	1	—	—	
Hot water--250°F. maximum									
ROOM HEATERS AND ROOM HEATING STOVES BURNING SOLID FUEL									
Circulating Type Vented or Unvented	Oil or Solid	36	—	24	12	12	18	—	
	Gas	36	—	24	12	12	—	9	
Radiant or Other Type Vented or Unvented	Oil or Solid	36	—	36	36	36	18	—	
	Gas	36	—	36	18	18	—	9	
	Gas with Double Metal or Ceramic Pack	36	—	36	12	18	—	9	
RADIATORS, SELF-CONTAINED ²									
Steam or Hot Water	Gas	36	—	6	6	6	—	9	
RANGES—COOKING STOVES									
Vented or Unvented	Oil	30	—	—	9	24	18	18	—
	Gas	30	—	—	6	6	6	—	6
	Solid—Clay lined Firepot	30	—	—	24	24	18	18	—
	Solid unlined Firepot	30	—	—	36	36	18	18	—
	Electric	30	—	—	6	6	—	—	—
CLOTHES DRYERS									
Listed Types	Gas	6	—	24	6	6	—	1	
	Electric	6	—	24	0	0 one side	—	—	
INCINERATORS									
Domestic Types		36	—	48	36	36	18	—	

TABLE NO. 51-A—(CONTINUED)

COMMERCIAL-INDUSTRIAL TYPE LOW-HEAT APPLIANCES ANY AND ALL PHYSICAL SIZES EXCEPT AS NOTED		APPLIANCE					CHIMNEY CONNECTOR (Inches)	VENT CON- NECTOR ⁵ (Inches)
		Above Top of Casing or Appliance (Inches) ¹⁰	From Top and Sides of Warm-Air Bonnet or Plenum (Inches)	From Front ⁴ (Inches)	From Back ¹⁰ (Inches)	From Sides ¹⁰ (Inches)		
BOILERS AND WATER HEATERS ⁷								
FUEL								
100 cu. ft. physical capacity or less any p.s.i. steam	All fuels	18	—	48	18	18	18	—
50 p.s.i. or less—any size	All fuels	18	—	48	18	18	18	—
UNIT HEATERS								
Floor mounted or suspended —any size	Steam or hot water	1	—	—	1	1	—	—
Suspended 100 cu. ft. phys- ical capacity or less	Oil or Combination Gas-Oil	6	—	24	18	18	18	—
	Gas	6	—	18	18	18	—	9
Suspended over 100 cu. ft. physical capacity	All fuels	18	—	48	18	18	18	—
Floor mounted any size	All fuels	18	—	48	18	18	18	—

RANGES—RESTAURANT TYPE								
Floor mounted	All fuels	48	—	48	18	18	18	—
OTHER LOW-HEAT INDUSTRIAL APPLIANCES								
Floor mounted or suspended	All fuels	18	18	48	18	18	18	—
COMMERCIAL-INDUSTRIAL TYPE MEDIUM-HEAT APPLIANCES		11			11		11	
BOILERS AND WATER HEATERS								
Over 50 p.s.i.—over 100 cu. ft. physical capacity	All fuels	48	—	96	36	36	36	—
OTHER MEDIUM-HEAT INDUSTRIAL APPLIANCES.								
All sizes	All fuels	48	36	96	36	36	36	—
INCINERATORS								
All sizes		48	—	96	36	36	36	—
INDUSTRIAL TYPE HIGH-HEAT APPLIANCES								
All sizes	All fuels	180	—	360	120	120	—	—

¹Standard clearances may be reduced by affording protection to combustible material in accordance with Table No. 51-B.

²Steampipes and hot-water heating pipes shall be installed with a clearance of at least one inch (1") to all combustible construction or material, except that at the points where pipes carrying steam or hot water at not over 15 pounds gauge pressure emerge from a floor, wall, or ceiling, the clearance at the opening through the finish floor boards or wall ceiling boards may be reduced to not less than one-half inch ($\frac{1}{2}$ "). Each such opening shall be covered with a plate of incombustible material.

Such pipes passing through stock shelving shall be covered with not less than one inch (1") of approved insulation.

Wood boxes or casings enclosing uninsulated steam- or hot-water heating pipes, or wooden covers to recesses in walls in which such uninsulated pipes are placed, shall be lined with metal or asbestos millboard.

Where the temperature of the boiler piping does not exceed 160°F., the provisions of this Table shall not apply.

Coverings or insulation used on steam- or hot-water pipes shall be of incombustible material. An appliance may be mounted on a combustible floor if the appliance is listed for such installation or if the floor is protected in an approved manner.

³Rooms which are large in comparison to the size of the appliance are those having a volume equal to at least 12 times the total volume of a furnace and at least 16 times the total volume of a boiler. If the actual ceiling height of a room is greater than eight feet (8'), the volume of a room shall be figured on the basis of a ceiling height of eight feet (8').

⁴The minimum dimension shall be that necessary for servicing the appliance including access for cleaning and normal care, tube removal, etc.

⁵The minimum dimension shall be eighteen inches (18") for gas appliances not equipped with draft hoods, except clothes dryers. The dimension may be six inches (6") for listed gas appliances equipped with draft hoods and for boilers and furnaces equipped with listed conversion burners and with draft hoods. A vent connector of listed Type B or L venting material may be used with listed gas appliances with draft hoods and may be installed at clearances marked on the material.

⁶For a listed oil, combination gas-oil, gas or electric furnace this dimension may be two inches (2") if the furnace limit control cannot be set higher than 250°F. or this dimension may be one inch (1") if the limit control cannot be set higher than 200°F.

⁷The dimension may be six inches (6") for an automatically stoker-fired forced warm-air furnace equipped with 250°F. limit control and with barometric draft control operated by draft intensity and permanently set to limit draft to a maximum intensity of thirteen hundredths-inch (.13") water gauge.

⁸To combustible material or metal cabinets. If the underside of such combustible material or metal cabinet is protected with asbestos millboard at least one-fourth inch ($\frac{1}{4}$ ") thick covered with sheet metal of not less than No. 28 gauge, the distance may be not less than twenty-four inches (24").

⁹Clearance above charging door shall be not less than forty-eight inches (48").

¹⁰If the appliance is encased in brick, the eighteen-inch (18") clearance above and at sides and rear may be reduced to not less than twelve inches (12").

¹¹If the appliance is encased in brick the clearance above may be not less than thirty-six inches (36"), and at sides and rear may be not less than eighteen inches (18").

If such openings or ducts convey air from an attic space, the attic space shall be ventilated by fresh air openings or louvers on a vertical wall or at two different levels or elevations.

**Fresh-Air Supply
for Combustion
and Ventilation
(Continued)**

(d) **Louvers and Grilles.** In calculating free area of all louvers and grilles, consideration shall be given to the blocking effect of the louvers, grilles or screens protecting openings. Screens used shall not be smaller than one-fourth-inch ($\frac{1}{4}$ ") mesh. If the free area through a design of louvers or grilles is known it should be used in calculating the size of opening required to provide the free area specified. If the design and free area are not known it may be assumed that wood louvers will have 20 per cent to 25 per cent free area and metal louvers and grilles have 60 per cent to 75 per cent free area.

Sec. 5103. (a) General. Every heat-producing appliance shall be accessible for inspection, service, repair and replacement without removing permanent construction.

Not less than thirty inches (30") of working space shall be provided in front of the appliance firebox opening for observing, operating, repairing, or replacing the burner, controls, and pilot burner. The operating instructions must be in a position where they can be easily read.

**TABLE NO. 51-B—REDUCED CLEARANCES WITH SPECIFIED
FORMS OF PROTECTION (In Inches)¹**

TYPES OF PROTECTION Applied to the combustible material and covering all surfaces within the distance specified as the required clearance with no protection. Thicknesses are minimum.	WHERE THE REQUIRED CLEARANCE WITH NO PROTECTION IS			
	36 Inches	18 Inches	9 Inches	6 Inches
(a) $\frac{1}{4}$ " asbestos millboard spaced out 1" ²	30	12	6	3
(b) No. 28 gauge sheet metal on $\frac{1}{4}$ " asbestos millboard	24	12	4	2
(c) No. 28 gauge sheet metal spaced out 1" ²	18	9	4	2
(d) No. 28 gauge sheet metal on $\frac{1}{4}$ " asbestos millboard spaced out 1" ²	18	9	4	2
(e) $\frac{1}{4}$ " asbestos millboard on 1" rockwool bats rein- forced with wire mesh or equivalent	18	6	4	2
(f) No. 22 gauge sheet metal on 1" rockwool bats rein- forced with wire or equiv- alent	12	3	2	2

¹All clearances shall be measured from the outer surface of the connector to the combustible material disregarding any intervening protection applied to the combustible material but in no case shall the clearance be such as to interfere with the requirements for accessibility.

²Spacers shall be of incombustible material.

Access

(Continued)

(b) **Appliance Space.** Every appliance space shall have an opening or door and passageway large enough to permit removal of the appliance. In no case shall such door and passageway be less than twenty-four inches (24") in width.

(c) **Horizontal-type Furnaces Installed Under First Floor or in Attic or Similar Approved Spaces.** All such furnaces shall comply with the following requirements:

1. All portions of such furnace shall be not less than six inches (6") from combustible construction, unless otherwise specified on the furnace label.

The draft hood relief opening for any such furnace shall be not less than twelve inches (12") from any surface measured at right angles to the relief opening.

The furnace vent outlet, blower fan, air filters, and all controls on such furnace shall be accessible for service and replacement from an unobstructed working space the length of the furnace and not less than thirty inches (30") in height or width.

An opening and passageway, with sufficient dimension to permit removal of the furnace without removing any permanent construction, shall be provided to the required working space in front of such furnace, but in no case shall be less than thirty inches (30") in height or width.

Such access openings may be through an opening in the exterior wall of the building or through a trap door within the building.

The opening to the passageway shall be located not more than twenty feet (20') from the furnace, measured along the center line of the passageway.

An electric light shall be provided at or near the furnace location, controlled by a switch located at or ahead of the passage opening.

**TABLE NO. 51-C—COMBUSTION AND VENTILATION AIR REQUIREMENTS
FOR GAS-BURNING APPLIANCES**

INPUT RATING	CONDITION NO. 1 Minimum Total Free Area of Ducts or Openings, Where Floor Area of Compartment Is Less Than Twice the Floor Area of the Appliance Therein	CONDITION NO. 2 Minimum Total Free Area of Ducts or Openings, Where Floor Area of Compartment Is More Than Twice the Floor Area of the Appliance Therein
0 through 500,000 B.t.u.'s	2 Sq. in. for each 1000 B.t.u.'s	1 Sq. in. for each 1000 B.t.u.'s
500,001 through 1,000,000 B.t.u.'s	1000 Sq. in. plus 2 sq. in. for each 1500 B.t.u.'s over 500,000 B.t.u.'s	500 Sq. in. plus 1 sq. in. for each 1500 B.t.u.'s over 500,000 B.t.u.'s
In excess of 1,000,000 B.t.u.'s	1666 Sq. in. plus 2 sq. in. for each 2000 B.t.u.'s over 1,000,000 B.t.u.'s	833 Sq. in. plus 1 sq. in. for each 2000 B.t.u.'s over 1,000,000 B.t.u.'s

2. All such furnaces installed in attics and similarly approved spaces shall comply with the following additional requirements: **Access (Continued)**

The required working space at the controls and required passageway shall be solidly floored to a width of thirty inches (30").

An approved ladder permanently fastened to the building or access space shall be provided leading directly to the furnace access opening.

3. All such furnaces installed under the first floor shall comply with the following additional requirements:

The lowest portion of any suspended furnace shall have at least a six-inch (6") clearance from the ground or a two-inch (2") clearance from concrete.

Whenever it is necessary to excavate to install any such furnace, such excavation or pit and the passageway thereto shall be lined with at least four inches (4") of watertight concrete or masonry extending at least four inches (4") above the surrounding ground. Such excavation shall extend twelve inches (12") on all sides of the furnace except the control side which shall have a thirty-inch (30") clearance.

The floor of such excavation shall have a concrete slab not less than four inches (4") thick.

All furnaces supported on the ground shall rest on a concrete slab extending not less than four inches (4") above the adjoining ground level or may be set on the floor slab of any approved pit.

(d) **Floor Furnace.** The space in which any floor furnace is installed shall be accessible by an opening in the foundation not less than twenty-four inches by eighteen inches (24" x 18") or trap door not less than twenty-four inches by eighteen inches (24" x 18") in any cross section thereof, and a passageway not less than twenty-four inches by eighteen inches (24" x 18") in any cross section thereof. The passageway shall be continuous from the opening or trap door to the furnace controls and valves, and the opening or trap door to the furnace controls and valves and the openings to the passageway shall be located not more than twenty feet (20') from the furnace.

(e) **Water Heaters.** Access to water heaters installed in an attic shall comply with the provisions of Subsection (c) to provide suitable access.

Sec. 5104. (a) Automatic Devices for Use on Residential Space Heating Appliances. Requirements shall be as follows: **Residential Space Heating Devices and Controls**

1. All natural, manufactured, or mixed gas-burning appliances shall be equipped with approved devices which will shut off the gas to the main burner or burners in the event of pilot failure.

2. Liquefied petroleum or mixed liquefied petroleum gas-air-burning appliances shall be equipped with automatic de-

**Residential Space
Heating Devices
and Controls
(Continued)**

vices which will shut off the flow of gas to the pilot and main burner or burners in the event of pilot failure.

3. Liquid-fuel-burning appliances shall be equipped with approved devices to shut off the fuel supply to the main burner or burners in the event of ignition failure.

(b) **Remote Controls.** All heating appliances whose manual controls are not readily accessible from the main portion of the dwelling being heated shall be equipped with remote controls.

EXCEPTION: Hand-fired equipment burning solid or liquid fuel.

(c) **Limit Controls.** Where a gravity warm-air heating system is installed with at least one warm-air outlet not less than thirty-five square inches (35 sq. in.) and permanently open and unobstructed, except for an open-faced grille, a temperature-limit control will not be required on the appliance. Any warm-air heating appliance which conveys heat through duct work shall be equipped with an approved temperature-limit control located in the bonnet or plenum. Such limit control shall have a fixed stop which will limit the outlet air temperature to 250°F.

**Space Heating
Furnaces and
Boilers**

Sec. 5105. (a) General. The equipment covered by this Section shall be installed according to the provisions of this Chapter. Such equipment shall not be altered nor shall the fuel input be increased in excess of the manufacturer's rated input. Defective material or parts shall be replaced in such a manner as not to invalidate the approvals as specified in Section 5101 (b).

(b) **Labeling.** Equipment covered by this Section shall bear a permanent and legible name plate on which shall appear:

1. The manufacturer's name.
2. The manufacturer's rating of the appliance.
3. A model designation.
4. Instructions for the lighting, operation, and shutdown of the appliance.
5. The type of fuel approved for use in the appliance.
6. A seal of approval of the appliance by an approved testing laboratory if acceptance is based on such approval.

(c) **Air Supply for Combustion.** Air for combustion shall be supplied as specified in Section 5102.

(d) **Circulating Air Supply.** Circulating air for heating systems may be taken from outside the building, from the heated area inside the building, or from both sources. Such circulating air shall be conducted to a blower type of furnace through ducts to provide a positive separation between the combustion air and circulating air supply. The circulating air supply opening or duct to every blower type comfort heating system and to every gravity type warm-air furnace shall have a cross-sectional area of not less than the total area of all warm-air outlets from such furnace, except that in no case used the

**Space Heating
Furnaces and
Boilers
(Continued)**

circulating air opening be larger than the outlet opening on the furnace. No damper shall be placed in any such air intake in a manner which will reduce the required circulating air supply to the furnace.

Circulating air supply for every blower type warm-air furnace shall be conducted into the blower housing from outside the furnace space by continuous airtight ducts except as provided in Subsection (d) 1.

No circulating air for any blower type warm-air furnace shall be taken from any of the following locations:

1. The same enclosed space in which any firebox opening draft diverter, or combustion air inlet, is located.

EXCEPTION: This provision shall not apply to any blower type warm-air furnace located in a room, the volume of which exceeds one cubic foot for each 10 B.t.u. fuel input rate of all fuel burning appliances in such room and further provided that at least 75 per cent of the heated air is discharged back into the area in which such appliance is located.

2. Closer than ten feet (10') from any appliance vent outlet, unless such vent outlet is at least four feet (4') above the circulating air inlet.

3. Where it will pick up objectionable odors, fumes, or flammable vapors.

4. From an area served by the furnace which is less than 25 per cent of the entire area served.

(e) **Venting.** Heating furnaces or boilers covered by this Section shall be connected to a vent or chimney complying with Chapter 37 of this Code.

(f) **Location.** Space heating furnaces and boilers shall be located in accordance with the following requirements:

1. Heating furnaces shall not be installed in an attic unless of a type approved for such use.

2. Floor furnaces may be installed in an upper floor provided the furnace assembly projects below into a utility room, closet, garage, or similar nonhabitable space. In such installations where fire separation is required the furnace shall be entirely separated from the nonhabitable space by means of the required fire-resistive construction. Adequate means for air intake and service access shall be provided. Minimum furnace clearance of six inches (6") on all sides shall be maintained between the furnace and enclosure.

3. No forced-air or gravity central heating furnaces shall be located in any room used or designed to be used for sleeping purposes, bathroom, clothes closet, or in any confined space with access only to the above locations excepting sealed combustion chamber appliances. No warm-air furnace shall be located in or serve any surgical operating room or other hazardous location.

**Space Heating
Furnaces and
Boilers
(Continued)**

(g) **Floor Furnaces.** 1. The floor around the furnace shall be braced and headed with a framework of material not lighter than the joists or girders.

Floor furnaces shall be supported independently of the grilles.

The lowest portion of the floor furnace shall have at least a six-inch (6") clearance from the ground, except that where the lower six-inch (6") portion of the floor furnace is sealed by the manufacturer to prevent entrance of water, the clearance may be reduced to not less than two inches (2"). When that clearance is not present, the ground below and to the sides shall be excavated to form a "basin-like" pit under the furnace so that there is a six-inch (6") clearance beneath the lowest portion of the furnace and a twelve-inch (12") clearance on all sides, except the control side which shall have an eighteen-inch (18") clearance. Whenever the excavation exceeds twelve inches (12") in depth, or water seepage is likely, a watertight copper pan, concrete pit, or other suitable material shall be used. A copper pan shall be made of not less than sixteen ounce per square foot sheet copper. The pan shall be anchored in place, so as to prevent floating, and the walls shall extend at least four inches (4") above the adjacent ground level, with twelve-inch (12") clearances on all sides except the control side, which shall have eighteen-inch (18") clearance. When the equipment is sealed by the manufacturer to meet this condition, the pan or pit may be omitted if not required for maintaining a dry condition for service access.

Floor furnaces shall not be installed where concrete slab floors are used.

(h) **Clearances.** 1. **Heating furnaces.** Clearances of heating furnaces and boilers except floor furnaces from combustible material shall be as follows:

Except as herein provided, heating furnaces and boilers shall be installed to provide clearances to woodwork or other combustible material whether plastered or unplastered, not less than as set forth in Table No. 51-A. Floor-mounted direct-fired unit heaters shall be installed with clearances as set forth in Table No. 51-A for appliances of similar heat-producing characteristics.

Heating furnaces and boilers which are approved for installation with lesser clearances than specified in this Subsection may be installed in accordance with the conditions of such approval.

2. **Floor furnaces.** With the exception of wall-register models, a floor furnace shall not be placed closer than six inches (6") to the nearest wall, and wall-register models shall not be placed closer than six inches (6") from a corner.

The furnace shall be so placed that a door cannot be nearer than twelve inches (12") to any portion of the register of the furnace.

**Room or Space
Heaters and
Room Heating
Stoves**

Sec. 5106. (a) General. The equipment covered by this Section shall be installed according to the provisions of this Chapter. Such equipment shall not be altered nor shall the fuel input be increased in excess of the manufacturer's rated input. Defective material or parts shall be replaced in such a manner as not to invalidate the approvals as specified in Section 5101 (b).

(b) Labeling. All equipment covered by this Section shall be labeled as specified in Section 5105 (b) for furnaces and boilers.

(c) Venting. Heating appliances covered by this Section other than those with sealed combustion chambers shall be connected to a flue vent or chimney complying with Chapter 37 of this Code.

EXCEPTION: Gas-heating appliances other than those in Groups D, H and I Occupancies need not be vented if designed without a vent collar and so listed and approved for use without a flue vent or chimney by an approved testing laboratory.

(d) Location. Room heaters and room heating stoves shall be placed so as not to cause a hazard to walls, floors, and doors. Room heaters designed and marked "for use in incombustible fire-resistive fireplace only," shall not be installed elsewhere.

(e) Clearances. 1. Gas-fired approved room and space heaters. Approved room and space heaters shall be installed with clearances from combustible construction as set forth in Table No. 51-A.

2. Untested room and space heaters. Untested gas-fired room or space heaters shall be installed with clearances from combustible construction not less than the following:

CIRCULATING TYPE, room heaters having an outer jacket surrounding the combustion chamber, arranged with openings at top and bottom so that air circulates between the inner and outer jacket, and without openings in the outer jacket to permit direct radiation. Such heaters shall have clearances at sides and rear of not less than twelve inches (12").

RADIANT TYPE, room heaters other than those described above as circulating type. Such heaters shall have clearances at sides and rear of not less than eighteen inches (18") except that heaters which make use of metal, asbestos, or ceramic material to direct radiation to the front of the appliance, shall have a clearance of thirty-six inches (36") in front, and if constructed with a double back of metal or ceramic may be installed with a clearance of eighteen inches (18") at sides and twelve inches (12") at rear.

3. Heaters burning liquid fuel and room heaters burning solid fuel. Clearances shall be as set forth in Table No. 51-A.

4. All other types. All other room or space heaters shall have a clearance at side and rear of not less than eighteen inches (18") with the floor protected in an approved manner. Reduced clearances shall be as set forth in Table No. 51-A.

(f) **Support.** Suspended-type unit heaters shall be safely and adequately supported with due consideration given to their weight and vibration characteristics.

Ducts

Sec. 5107. (a) General. These requirements apply to air duct systems employing mechanical means for the movement of air and used for heating and ventilating, including warm-air heating systems, plain ventilating systems, combination heating and ventilating systems, and exhaust systems. They do not apply to systems for removal of flammable vapors and residues nor to systems for conveying dust, stock or refuse by means of air currents.

(b) **Construction and Installation.** All warm-air pipe and fittings, ducts, boxes and fittings shall be constructed and installed in accordance with nationally recognized practices and principles.

(c) **Joints and Seams of Round Ducts.** Joints and seams of round ducts shall be securely fastened and made substantially airtight. Slip joints shall have a contact lap of at least one and one-half inches ($1\frac{1}{2}$ ") and shall be individually fastened at not less than three points. Tapes used for sealing joints shall not be more combustible than approved flameproof fabric.

(d) **Duct Sizing—Grilles or Louvers.** If grilles or louvers are used on ducts or openings the free area shall be used to calculate the required area of such openings. If the design and free area are not known, it may be assumed that wood louvers and grilles will have 20 per cent to 25 per cent free area and metal louvers and grilles will have 60 per cent to 75 per cent free area.

(e) **Duct Material.** Ducts shall be constructed entirely of approved incombustible material. Ducts constructed of metal shall comply with Table No. 51-D.

Ducts may be of independent construction or a part of the building structure, provided that they are installed in accordance with the requirements of this Section. Construction consisting of not less than three-fourths-inch ($\frac{3}{4}$ ") cement or gypsum plaster on metal lath applied to both sides of either combustible or incombustible supports may be used as duct walls.

EXCEPTION: Return air ducts in Group I Occupancies may be constructed of metal, of one-inch (1") (nominal) smooth surfaced wood boards or other approved materials, provided that no materials more flammable than one-inch (1") board be used. Portions of return air ducts directly above or below the heating surface or closer than two feet (2') from the outer jacket of the heater shall be constructed of incombustible material. Where space between studs in walls or partitions is used as a duct the portions of such space so used shall be cut off from all remaining unused portions by tight-fitting stops of sheet metal or of wood not

Ducts
(Continued)

less than two inches (2") nominal thickness. Not more than one firestop may be crossed.

(f) **Ducts Under Slab.** Metal ducts, metal fittings, approved laminated or other fiber ducts shall be encased in not less than two inches (2") of concrete and with a minimum of two and one-half inches (2½") of concrete above such duct or fittings.

Asbestos-cement ducts, concrete ducts, clay or ceramic ducts shall be installed in the fill below the slab with not less than two and one-half inches (2½") of concrete above the ducts. All joints shall be made substantially water and vapor tight.

(g) **Ducts in Garages.** Exposed ducts and fittings in single family garage, housing not more than three cars, shall be not less than No. 26 galvanized sheet gauge and located not less than seven feet (7') above the floor of the required car storage space. See Table No. 5-B for required occupancy separation between Groups I and J Occupancies.

(h) **Vibration Isolation Connectors.** Vibration isolation connectors within the furnace room shall be made of woven asbestos or approved flameproof fabric. Isolation connectors of fabric shall not exceed ten inches (10") in length.

(i) **Flexible Duct Connectors.** Flexible duct connectors may be approved provided such connectors:

1. Are not subject to mildew or moisture.
2. Are not more combustible than flameproof fabrics.
3. Do not exceed twelve feet (12') in length.
4. Do not exceed eight inches (8") in diameter.
5. Do not pass through any fire wall, fire partition or floor.
6. Are not used within six feet (6') of the heating element.
7. Are not used on furnaces equipped with a high limit switch capable of a setting above 250°F.

(j) **Duct Covering or Insulation.** All wall risers, register boxes and fittings shall be wrapped with not less than one layer of asbestos insulation or approved equal. All insulation shall be applied securely.

EXCEPTIONS: 1. Exposed ducts within the conditioned space need not be wrapped.

2. All ducts which are exposed to the weather and are required to be insulated shall have approved insulation on the inside of the duct.

(k) **Duct Linings.** Only nonerosive insulation and flameproof duct lining shall be used inside of ducts. Such lining shall be secured by approved clips or approved adhesive materials.

(l) **Pipes and Boxes on Outside Walls.** Riser pipes and register boxes installed in outside walls shall be insulated with one layer of air-cell asbestos or equal insulation on the weather side.

(m) **Strapping.** Requirements for strapping are as follows:

1. All riser pipes shall be held in place by means of metal

TABLE NO. 51-D—MINIMUM THICKNESS OF METAL FOR AIR DUCTS¹

Two gauges heavier shall be used when air pressure in duct exceeds one-inch (1") water column pressure.

MAXIMUM DIAMETER OF ROUND OR SIDE OF RECTANGULAR DUCTS AND FITTINGS (In Inches)	GALVANIZED IRON OR STEEL		ALUMINUM DUCT SHEET		COPPER COLD-ROLLED MINIMUM WEIGHT (In Ounces)	TIN-PLATE MINIMUM WEIGHT (In Pounds)	
	Thickness (In Inches)	Galvanized Sheet Gauge	Thickness (In Inches)	B. & S. Gauge			
RESIDENTIAL							
14 or less	.0125	30	.016	26		107	Enclosed in wall or partition
Over 14	.0156	28	.016	26		135	
14 or less	.0156	28	.016	26		107	Not enclosed in wall or partition
Over 14	.0187	26	.020	24		135	
NONRESIDENTIAL							
12 or less	.0187	26	.020	24	16		
13 to 31	.0250	24	.025	22	24		
31 to 55	.0312	22	.032	20	32		
55 to 85	.0375	20 ²	.040	18 ²	36		
85 to 97	.050	18 ³	.050	16 ³	48		
Over 97		Determined by design stiffness required as approved by Building Official					

¹Alternate materials may be used provided they are installed and used in accordance with their individual approval.²Next gauge lighter may be used provided girth seams not more than three feet nine inches (3'9") apart, or one and one-half-inch by one and one-half inch by one-eighth-inch (1½" x 1½" x ⅛") metal angle frames not more than four feet (4') apart or midway between joints are used.³Next gauge lighter may be used provided one and one-half-inch by one and one-half-inch by one-eighth-inch (1½" x 1½" x ⅛") metal angle frames not more than three feet (3') apart or midway between joints are used.

straps. In no case shall the riser be nailed diagonally through the corner of the pipe.

2. Lateral pipes up to twelve inches (12") in diameter or width may be fastened in place by means of No. 18 gauge wire or metal straps every six and one-half feet (6½') of horizontal run.

3. Lateral pipes of thirteen inches (13") to twenty-four inches (24") shall be held in place by a No. 28 gauge galvanized strap, not less than three-fourths inch (¾") wide and not less than six and one-half feet (6½') of horizontal run.

4. Lateral pipe of over twenty-five inches (25") shall be held in place by a strap not less than the gauge of the duct and not less than one-inch (1") width at every joint.

5. No joint shall depend wholly on solder for its support.

(n) **Corridors as Plenums.** Corridors required to be of fire-resistive construction shall not be used as plenums for Group D, F, Division 2, or H Occupancies.

(o) **Use of Underfloor Space as Supply Plenum.** If approved by the Building Official before installation, an underfloor space may be used as a supply plenum provided:

1. Use of such spaces shall be restricted to one-story portions of single family residences.

2. Such spaces shall be not more than twenty-four inches (24") in height to the bottom of floor joist; shall be cleaned of all combustible material, and shall be tightly and substantially enclosed.

3. The enclosing material of the underfloor space including the side wall insulation shall be not more flammable than one-inch (1") (nominal) wood boards (flame-spread classification of 200). Combustible ground cover shall be covered over with at least two inches (2") of sand or other incombustible material.

4. Access shall be through an opening in the floor and shall be not less than twenty-four inches by twenty-four inches (24" x 24").

5. The furnace supplying warm air to such space shall be equipped with an automatic control which will start the air circulating fan when the air in the furnace bonnet reaches a temperature not higher than 150°F. Such control shall be one that cannot be set higher than 150°F.

6. The furnace supplying warm air to such space shall be equipped with an approved temperature limit control that will limit outlet air temperature to 200°F.

7. An incombustible receptacle shall be placed below each floor opening into the air chamber, and such receptacle shall conform to the following:

A. The receptacle shall be securely suspended from the floor members and shall be not more than eighteen inches (18") below the floor opening.

B. The area of the receptacle shall extend three inches (3") beyond the opening on all sides.

Ducts
(Continued)

Ducts
(Continued)

C. The perimeter of the receptacle shall have a vertical lip at least one inch (1") high at the open sides if it is at the level of the bottom of the joists, or three inches (3") high if the receptacle is suspended.

8. Floor registers shall be designed for easy removal in order to give access for cleaning the receptacles.

9. Exterior walls and interior stud partitions shall be fire-stopped at the floor.

10. Each wall or floor register shall be connected to the air chamber by a register box or boot with shield directly below the register opening.

11. Supply ducts to the air chamber shall terminate not less than six feet (6') from the plenum chamber.

(p) **Register Box and Riser Pipe Fittings.** Connection of round pipe to rectangular wall risers or register boxes shall be made by properly designed tapered fittings, with a collar to permit a one and one-half-inch (1½") slip connection.

Incinerators

Sec. 5108. (a) General. Incinerators for the reduction of refuse, garbage, or other waste materials shall be installed in accordance with the provisions of this Section. Materials and structural design shall meet the requirements of Part VI of this Code.

(b) **Small Domestic Type.** Incinerators of small uninsulated domestic type installed indoors shall be constructed, mounted, installed, and vented according to the applicable requirements for room heating stoves burning solid fuel and room heaters burning liquid fuel as specified in Section 5106, except that mounting shall be on an incombustible and fire-resistant floor, and minimum clearances to combustible material shall be thirty-six inches (36") above, forty-eight inches (48") in front, and thirty-six inches (36") in back and at sides. The requirements of this Subsection shall also apply to incinerators installed as a part of other appliances.

Incinerators of small domestic type, or those that are a part of another appliance, which have been tested and approved by an approved testing agency and approved for installation on a combustible floor or with lesser clearances shall be installed in accordance with the conditions of such approval and shall be connected to a Type A flue or vent complying with the requirements of Chapter 37.

Outdoor incinerators of small domestic type shall be constructed and located to meet the approval of the chief of the Fire Department.

(c) **Incinerators Using the Flue as a Refuse Chute.** Incinerators in which no fuel other than normal refuse, except a gas flame or similar means to accomplish ignition, is used for combustion, and in which the chute and smoke flue are identical, shall have the enclosing walls of the combustion chamber constructed of clay or shale brickwork not less than four inches (4") thick when there is a horizontal grate area of not more than nine square feet (9 sq. ft.) and not less than eight inches

**Incinerators
(Continued)**

(8") thick when there is a horizontal grate area exceeding nine square feet (9 sq. ft.) and, in each case, a lining of firebrick not less than four inches (4") thick, with an air space, in the case of the thicker wall, between the clay or shale brick and the firebrick sufficient to provide for expansion and contraction.

The combined chute and flue shall be constructed as required for incinerator chimneys in Section 3703 (e). Such chute and flue shall be constructed straight and plumb, and finished smooth on the inside. All flues shall terminate in a substantially constructed spark arrester having a mesh not exceeding three-fourths inch ($\frac{3}{4}$ ").

Firebrick shall be laid in fire-clay mortar.

Service openings into the chute shall be equipped with approved self-closing hoppers so constructed that the openings are closed off while the hopper is being charged and no part will project into the chute or flue. The area of the service opening shall not exceed one-third of the area of the chute or flue.

(d) Commercial and Industrial Type Incinerators. Commercial and industrial type incinerators designed to burn not more than 250 pounds of refuse per hour and having a horizontal grate area not exceeding nine square feet (9 sq. ft.) shall have enclosing walls of the combustion chamber constructed of clay or shale brick not less than eight inches (8") thick, with a lining of firebrick not less than four inches (4") thick, provided that the outer four inches (4") of clay or shale brickwork may be replaced by a steel plate casing not less than three-sixteenths inch ($\frac{3}{16}$ ") in thickness.

Commercial and industrial types of incinerators of a size designed to burn more than 250 pounds of refuse per hour and having a grate area exceeding nine square feet (9 sq. ft.) shall have enclosing walls of the combustion chamber constructed of clay or shale brick not less than eight inches (8") thick with a lining of firebrick not less than eight inches (8") thick, provided that the outer four inches (4") of clay or shale brickwork may be replaced by a steel plate casing not less than three-sixteenths inch ($\frac{3}{16}$ ") in thickness.

Combustion chamber walls shall be strongly braced and stayed with structural steel shapes, and the firebrick linings shall be laid in fire-clay mortar.

Incinerators with their waste material bins or containers shall be located in a room or compartment used for no other purpose, or in a room devoted exclusively to boilers and heating plant. In either case such room shall be separated from the rest of the building by two-hour fire-resistive walls, floors, and ceilings, with all openings equipped with a fire assembly having a three-hour fire-resistive rating.

The flue connections or breechings from the combustion chamber shall be constructed of not lighter than No. 16 U. S. gauge metal when they do not exceed twelve inches (12") in

**Incinerators
(Continued)**

diameter or greatest dimension, and of No. 12 U. S. gauge metal when they exceed twelve inches (12") in diameter or greatest dimension. In addition they shall be lined with fire-brick, laid in fire-clay mortar, not less than two and one-half inches (2½") thick when they are between twelve inches (12") and eighteen inches (18") in diameter or greatest dimension, and not less than four and one-half inches (4½") thick when they are larger. If they lead into and combine with flue connections or breechings from other appliances, such other connections or breechings shall also be lined as required for direct flue connections, unless the cross-sectional area of the connection into which they lead is at least four times the area of the incinerator connection.

The clearance to woodwork or other combustible material or construction, on all sides of flue connections or breechings, shall be not less than thirty-six inches (36") provided that clearances may be modified as set forth in Table No. 51-B.

Refuse chutes shall not feed directly to the combustion chamber, but shall discharge into a room or bin enclosed and separated from the incinerator room by floors, ceilings and walls of not less than two-hour fire-resistive construction. The opening through which material is transferred from such room or bin to the incinerator room shall be equipped with a fire assembly having a three-hour fire-resistive rating.

Refuse chutes shall rest on substantial incombustible foundations. The enclosing walls of such chutes shall consist of clay or shale brickwork not less than eight inches (8") thick or of reinforced concrete not less than six inches (6") thick. Such chutes shall extend to but not less than four feet (4') above the roof and shall be covered by a metal skylight glazed with single thick plain glass.

Service openings for chutes shall be located in separate rooms or compartments enclosed in walls or partitions, floors, and ceilings having a fire-resistive rating of not less than one-hour. Such openings shall be equipped with a fire assembly having a one-hour rating.

(e) **Other Types.** Incinerators of types other than those regulated above shall be constructed and installed in accordance with the requirements of Section 5108 (d), except for special large-capacity incinerators and refuse burners used in connection with sawmills and woodworking plants and except for other approved types which incinerators shall meet the approval of the chief of the Fire Department.

**Miscellaneous
Domestic
Appliances**

Sec. 5109. (a) Clearances. 1. **Vertical clearance above cooking top.** Domestic free-standing or built-in ranges shall have a vertical clearance above the cooking top of not less than thirty inches (30") to unprotected combustible material. When the underside of such combustible material is protected with asbestos millboard at least one-fourth inch (¼") thick covered with sheet metal of not less than No. 28 U. S. gauge

or a metal ventilating hood, the distance shall be not less than twenty-four inches (24").

Miscellaneous
Domestic
Appliances
(Continued)

2. **Horizontal clearance of built-in top cooking units.** The minimum horizontal distance from the center of the burner head(s) of a top (or surface) cooking unit to adjacent vertical combustible surfaces extending immediately above the counter top shall be not less than that distance specified by the permanent marking on the unit.

(b) **Kitchen Ventilation.** There shall be installed in the wall or ceiling, approximately over the cooking facilities, a ventilating opening with a minimum area of eight inches by six inches (8" x 6"), connected by an incombustible ventilating duct free to the outside of the building. The ventilating duct for each kitchen shall have a minimum cross-sectional area of twenty-eight square inches (28 sq. in.). An approved forced-draft system of ventilation may be substituted for the natural-draft ventilating system.

(c) **Domestic Clothes Dryers.** Where a clothes dryer is connected to a moisture exhaust duct, it shall be installed in accordance with manufacturer's instructions and recommendations.

A clothes dryer moisture exhaust duct shall not be connected into any vent connector, gas vent, or chimney.

Ducts for exhausting clothes dryers shall not be put together with sheet metal screws or other fastening means which extend into the duct.

In no case shall the moisture exhaust terminate beneath the building or in the attic area.

CHAPTER 70—EXCAVATION AND GRADING

Sec. 7001. The purpose of this Chapter is to safeguard life, limb, property, and public welfare by establishing minimum requirements for regulating grading and procedures by which these requirements may be enforced. **Purpose**

Sec. 7002. This Chapter sets forth rules and regulations to control excavation, grading, and earthwork construction, including fills or embankments; establishes the administrative procedure for issuance of permits; and provides for approval of plans and inspection of grading construction. **Scope**

Sec. 7003. No person shall do any grading without first having obtained a grading permit from the Building Official, except for the following: **Permits Required and Exceptions**

1. An excavation which (a) is less than two feet (2') in depth, or (b) which does not create a cut slope greater than five feet (5') in height and steeper than one and one-half horizontal to one vertical.

**Permits Required
and Exceptions
(Continued)**

2. A fill less than one foot (1') in depth, and placed on natural terrain with a slope flatter than five horizontal to one vertical, or less than three feet (3') in depth, not intended to support structures, which does not exceed 50 cubic yards on any one lot and does not obstruct a drainage course.

3. An excavation below finished grade for basements and footings of a building, retaining wall, or other structure authorized by a valid building permit. This shall not exempt any fill made with the material from such excavation nor exempt any excavation having an unsupported height greater than five feet (5') after the completion of such structure.

4. Excavation or deposition of earth materials within a property which is dedicated or used, or to be used for cemetery purposes, except where such grading is within one hundred feet (100') of the property line or intended to support structures.

5. Mining, quarrying, excavating, processing, stockpiling of rock, sand, gravel, aggregate, or clay where established and provided for by law provided that such operations do not affect the lateral support or unduly increase the stresses in or pressure upon any adjacent or contiguous property.

6. Grading in an isolated, self-contained area if the Building Official finds that no danger to private or public property can now or thereafter result from the grading operations.

**Hazardous
Conditions**

Sec. 7004. Whenever the Building Official determines that any existing excavation or embankment or fill has become a hazard to life and limb, or endangers property, or adversely affects the safety, use, or stability of a public way or drainage channel, the owner of the property upon which the excavation or fill is located, or other person or agent in control of said property, upon receipt of notice in writing from the Building Official shall within the period specified therein repair or eliminate such excavation or embankment so as to eliminate the hazard and be in conformance with the requirements of this Code.

Definitions

Sec. 7005. BEDROCK is the solid, undisturbed rock in place either at the ground surface or beneath surficial deposits of gravel, sand, or soil.

CERTIFY OR CERTIFICATION shall mean the specific inspections and tests where required have been performed and that such tests comply with the applicable requirements of this Chapter.

ENGINEERING GEOLOGY is the application of geological data and principles to engineering problems dealing with naturally occurring rock and soil for the purpose of assuring that geological factors are recognized and adequately interpreted in engineering practice.

EXISTING GRADE is the vertical location of the existing ground surface prior to excavating or filling.

**Grading Permit
Requirements
(Continued)**

(c) **Engineering Geological Reports.** Prior to issuance of a grading permit, the Building Official may require an engineering geological investigation, based on the most recent grading plan. The engineering geological report shall include an adequate description of the geology of the site, and conclusions and recommendations regarding the effect of geologic conditions on the proposed development.

All reports shall be subject to approval by the Building Official, and supplemental reports and data may be required as he may deem necessary. Recommendations included in the report and approved by the Building Official shall be incorporated in the grading plan.

(d) **Soils Engineering Reports.** The Building Official may require a soils engineering investigation, based on the most recent grading plan. Such reports shall include data regarding the nature, distribution, and strength of existing soils, conclusions and recommendations for grading procedures, and design criteria for corrective measures.

Recommendations included in the report and approved by the Building Official shall be incorporated in the grading plan or specifications.

**Permit Limitations
and Conditions**

Sec. 7007. (a) General. The issuance of a grading permit shall constitute an authorization to do only that work which is described or illustrated on the application for the permit, or on the site plans and specifications approved by the Building Official.

(b) **Jurisdiction of Other Agencies.** Permits issued under the requirements of this Code shall not relieve the owner of responsibility for securing required permits for work to be done which is regulated by any other code, department or division of the governing agency.

(c) **Time Limits.** The permittee shall fully perform and complete all of the work required to be done pursuant to the grading permit within the time limit specified. If no time limit is specified, the permittee shall complete the work within 80 days after the date of the issuance of the grading permit.

If the permittee is unable to complete the work within the specified time, he shall, prior to the expiration of the permit, present in writing to the Building Official a request for an extension of time, setting forth the reasons for the requested extension. If, in the opinion of the Building Official, such an extension is warranted, he may grant additional time for the completion of the work.

(d) **Storm Damage Precautions.** All persons performing any grading operations shall put into effect all safety precautions which are necessary in the opinion of the Building Official and shall remove all loose dirt from the grading site and provide adequate anti-erosion and/or drainage devices, debris

FILL is deposits of soil, rock, or other materials placed by man.

Definitions
(Continued)

FINISH GRADE is the final grade or elevation of the building site.

GRADING is any excavating or filling or combination thereof.

ROUGH GRADE is an approximate elevation of the ground surface conforming to the proposed design.

SITE is any lot or parcel of land or contiguous combination thereof, under the same ownership, where grading is performed or permitted.

SOIL is all earth material of whatever origin that overlies bedrock.

SOILS ENGINEERING shall mean the application of the principles of soils mechanics in the investigation and analysis of the engineering properties of earth material.

Sec. 7006. (a) Permits Required. Except as exempted in Section 7003 of this Code, no person shall do any grading without first obtaining a grading permit from the Building Official. A separate permit shall be required for each site, and may cover both excavations and fills.

Grading Permit
Requirements

(b) Plans and Specifications. With each application for a grading permit and when required by the Building Official for enforcement of any provisions of this Code, two sets of plans and specifications shall be submitted. Except as waived by the Building Official for small and unimportant work, the plans shall be prepared and signed by a civil engineer licensed by the state and shall show the following:

1. A vicinity sketch or other data adequately indicating the site location.

2. Property lines of the property on which the work is to be performed.

3. Location of any buildings or structures on the property where the work is to be performed, and the location of any building or structure on land of adjacent property owners which are within fifteen feet (15') of the property.

4. Accurate contours showing the topography of the existing ground.

5. Elevations, dimensions, location, extent and the slopes of all proposed grading shown by contours and other means.

6. A certification of the quantity of excavation and fill involved and estimated starting and completion dates.

7. Detailed plans of all drainage devices, walls, cribbing, dams, or other protective devices to be constructed in connection with, or as a part of, the proposed work, together with a map showing the drainage area and estimated runoff of the area served by any drains.

8. Any additional plans, drawings, or calculations required by the Building Official.

basins, or other safety devices to protect the life, limb, health, and welfare of private and public property of others from damage of any kind.

**Permit Limitations
and Conditions
(Continued)**

(e) **Conditions of Approval.** In granting any permit under this Code, the Building Official may attach such conditions as may be reasonably necessary to prevent creation of a nuisance or hazard to public or private property. Such conditions may include, but shall not be limited to:

1. Improvement of any existing grading to bring it up to the standards of this Code.
2. Requirements for fencing of excavations or fills which would otherwise be hazardous.

(f) **Liability.** Neither the issuance of a permit under the provisions of this Code, nor the compliance with the provisions hereof or with any conditions imposed in the permit issued hereunder, shall relieve any person from responsibility for damage to other persons or property, nor impose any liability upon the city for damage to other persons or property.

Sec. 7008. (a) Hazardous Grading. The Building Official shall not issue a permit in any case where he finds that the work as proposed by the applicant is liable to endanger any private property or result in the deposition of debris on any public way or interfere with any existing drainage course.

Denial of Permit

If it can be shown to the satisfaction of the Building Official that the hazard can be essentially eliminated by the construction of retaining structures, buttress fills, drainage devices or by other means, the Building Official may issue the permit with the condition that such work be performed.

(b) **Geological or Flood Hazard.** If, in the opinion of the Building Official, the land area for which grading is proposed is subject to geological or flood hazard to the extent that no reasonable amount of corrective work can eliminate or sufficiently reduce the hazard to human life or property, the grading permit and building permits for habitable structures shall be denied.

Sec. 7009. (a) Plan-checking Fee. For excavation and fill on the same site, the fee shall be based on the volume of the excavation or fill, whichever is greater. Before accepting a set of plans and specifications for checking, the Building Official shall collect a plan-checking fee. Separate permits and fees shall apply to retaining walls or major drainage structures as indicated elsewhere in this Code. There shall be no separate charge for standard terrace drains and similar facilities. The amount of the plan-checking fee for grading plans shall be as set forth in Table No. 70-A.

Fees

The fee for a grading permit authorizing additional work to that under a valid permit shall be the difference between the fee paid for the original permit and the fee shown for the entire project.

Fees

(Continued)

TABLE NO. 70-A—PLAN-CHECKING FEES

50 cubic yards or less.....	No Fee
50 to 100 cubic yards.....	\$10.00
101 to 1000 cubic yards.....	15.00
1001 to 10,000 cubic yards.....	20.00
10,001 to 100,000 cubic yards—\$20.00 for the first 10,000 cubic yards plus \$10.00 for each additional 10,000 cubic yards or fraction thereof.	
100,001 to 200,000 cubic yards—\$110.00 for the first 100,000 cubic yards plus \$6.00 for each additional 10,000 cubic yards or fraction thereof.	
200,001 cubic yards or more—\$170.00 for the first 200,000 cubic yards, plus \$3.00 for each additional 10,000 cubic yards or fraction thereof.	

(b) **Grading Permit Fees.** A fee for each grading permit shall be paid to the Building Official as set forth in Table No. 70-B.

TABLE NO. 70-B—GRADING PERMIT FEES

50 cubic yards or less.....	\$10.00
50 to 100 cubic yards.....	15.00
101 to 1000 cubic yards—\$15.00 for the first 100 cubic yards, plus \$7.00 for each additional 100 cubic yards or fraction thereof.	
1001 to 10,000 cubic yards—\$78.00 for the first 1000 cubic yards, plus \$6.00 for each additional 1000 cubic yards or fraction thereof.	
10,001 to 100,000 cubic yards—\$132.00 for the first 10,000 cubic yards, plus \$27.00 for each additional 10,000 cubic yards or fraction thereof.	
100,001 cubic yards or more—\$375.00 for the first 100,000 cubic yards, plus \$15.00 for each additional 10,000 cubic yards or fraction thereof.	

The fee for a grading permit authorizing additional work to that under a valid permit shall be the difference between the fee paid for the original permit and the fee shown for the entire project.

Bonds

Sec. 7010. (a) Bonds Required. A permit shall not be issued for more than 1000 cubic yards unless the permittee shall first post with the Building Official a bond executed by the owner and a corporate surety authorized to do business in this state as a surety in an amount sufficient to cover the cost of the project, including corrective work necessary to remove and eliminate geological hazards.

The bond shall include penalty provisions on a form approved by counsel for the governing agency, for failure to complete the work on schedule.

In lieu of a surety bond the applicant may file a cash bond with the Building Official in an amount equal to that which would be required in the surety bond.

(b) **Conditions.** Every bond shall include the conditions that the permittee shall:

1. Comply with all of the provisions of the Code, applicable laws, and ordinances;
2. Comply with all of the terms and conditions of the permit for excavation or fill to the satisfaction of the Building Official;
3. Complete all of the work contemplated under the permit within the time limit specified in the permit. (The Building Official may, for sufficient cause, extend the time specified in the permit, but no such extension shall release the surety upon the bond.)

Bonds.
(Continued)

(c) **Failure to Complete Work.** The term of each bond shall begin upon the date of filing and shall remain in effect until the completion of the work to the satisfaction of the Building Official. In the event of failure to complete the work and failure to comply with all of the conditions and terms of the permit, the Building Official may order the work required by the permit to be completed to his satisfaction. The surety executing such bond or deposit shall continue to be firmly bound under a continuing obligation for the payment of all necessary costs and expenses that may be incurred or expended by the governing agency in causing any and all such required work to be done. In the case of a cash deposit, said deposit or any unused portion thereof shall be refunded to the permittee.

Sec. 7011. (a) Maximum Slope. Cuts shall not be steeper in slope than one and one-half horizontal to one vertical unless the owner furnishes a soils engineering or an engineering geology report certifying that the site has been investigated and indicating that the proposed deviation will not endanger any private property or result in the deposition of debris on any public way or interfere with any existing drainage course.

**Design Standards
for Cuts**

The Building Official may require the excavation to be made with a cut face flatter in slope than one and one-half horizontal to one vertical if he finds it necessary for stability and safety.

(b) **Drainage Terraces.** Cut slopes exceeding forty feet (40') in vertical height shall be terraced at their approximate mid-height. Drainage terraces are to be a minimum of six feet (6') wide, paved and must carry water to a safe disposal area. Terraces shall be cut every thirty feet (30') vertically, except that where only one terrace is required, it shall be at mid-height.

Sec. 7012. (a) Compaction. All fills shall be compacted to a minimum of 90 per cent of maximum density as determined by U.B.C. Standard No. 70-1-64. Field density shall be determined by U.B.C. Standard No. 70-2-64 or equivalent as approved by the Building Official. If the Building Official determines that the strict enforcement of this Section is unduly

**Design Standards
for Fills**

**Design Standards
for Fills
(Continued)**

restrictive or imposes an undue hardship on the permittee, this requirement may be waived by the Building Official. This requirement shall not be waived when structures are to be supported by the fill or where the Building Official determines that compaction is necessary as a safety measure to aid in preventing the saturation, slipping, or erosion of the fill.

(b) **Preparation of Ground.** The natural ground surface shall be prepared to receive fill by removing vegetation, non-complying fill, top soil, and, where slopes are five horizontal to one vertical or steeper, by benching into sound bedrock or other competent material. Five feet (5') of the lowermost bench shall be exposed beyond the toe of the fill. The bench shall be sloped for sheet overflow or a paved drain shall be provided.

(c) **Fill Slope.** No compacted fill shall be made which creates an exposed surface steeper in slope than one and one-half horizontal to one vertical. The Building Official may require that the fill be constructed with an exposed surface flatter than one and one-half horizontal to one vertical if he finds this necessary for stability and safety.

Slopes of fills which are not compacted in accordance with Section 7012 (a) may not exceed two horizontal to one vertical.

(d) **Fill Material.** No organic material shall be permitted in fills. Except as permitted by the Building Official, no rock or similar irreducible material with a maximum dimension greater than eight inches (8") shall be buried or placed in fills.

(e) **Drainage Terraces.** All fill slopes in excess of thirty feet (30') vertical height shall have paved drainage terraces at vertical intervals not exceeding twenty-five feet (25') except that where only one terrace is required it shall be at mid-height. Such terraces shall drain into a paved gutter, pipe or other watercourse adequate to convey the water to a safe disposal area. The terrace shall be at least six feet (6') wide.

(f) **Slopes to Receive Fill.** Fills toeing out on natural slopes which are steeper than two horizontal to one vertical will not be permitted.

**Design Standards
for Setbacks**

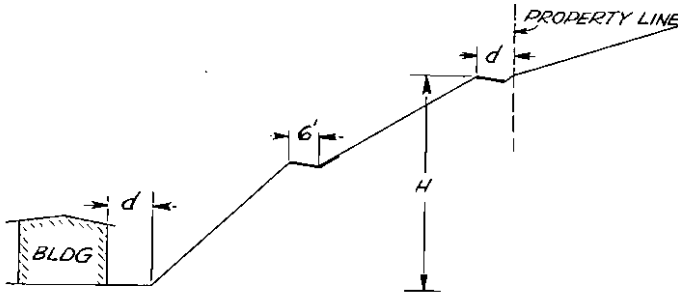
Sec. 7013. Cuts and fills shall be set back from property lines and buildings shall be set back from cut or fill slopes in accordance with Figure No. 1. Retaining walls may be used to reduce the required setback when approved by the Building Official.

Fill placed on or above the top of an existing or proposed cut or natural slope steeper than three horizontal to one vertical shall be set back from the edge of the slope a minimum distance of six feet (6').

Building foundations shall be set back from the top of slope a minimum distance of six feet (6') for all cut slopes steeper

EXCAVATED SLOPE

Figure No. 1



H FEET	REQUIRED SETBACKS		
	FILL SLOPES		CUT SLOPES
	a	b	d
0-15	1'6"	3'	3'
15-50	H/10	H/5	H/5
Over 50	H/10	H/5	10'

COMPACTED FILL SLOPE

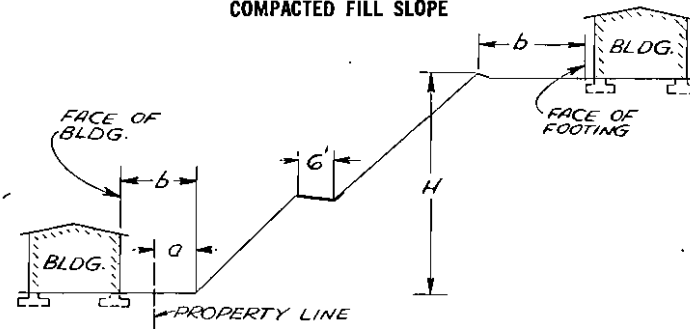


FIGURE NO. 1—REQUIRED SETBACKS

than two horizontal to one vertical. No buildings shall be constructed on cut or fill slopes steeper than two horizontal to one vertical.

The setbacks given in this Section are minimum and may be increased by the Building Official if considered necessary for safety or stability or to prevent possible damage from water, soil, or debris.

Sec. 7014. (a) Disposal. All drainage facilities shall be designed to carry surface waters to the nearest practical street, storm drain, or natural watercourse approved by the Building Official and/or other appropriate governmental agency, as a safe place to deposit such waters. At least two per cent grade

**Design Standards
for Setbacks
(Continued)**

**Design Standards
for Drainage**

**Design Standards
for Drainage
(Continued)**

toward the approved disposal area will be required for building pads, except as waived by the Building Official for non-hilly terrain.

(b) **Erosion Prevention.** Adequate provision shall be made to prevent any surface waters from damaging the face of an excavation or fill. All slopes shall be protected from surface water runoff from above by berms or swales.

(c) **Terrace Drains.** All swales or ditches on drainage terraces shall have a minimum grade of five per cent and must be paved. Drainage devices shall be paved with concrete with a minimum thickness of three inches (3") or approved equal. They shall have a minimum depth at the deepest point of one foot (1').

If the drain discharges onto natural ground riprap may be required.

Planting

Sec. 7015. The face of all cut and fill slopes shall be planted and maintained with a ground cover approved by the Building Official to protect the slopes against erosion as soon as practical and prior to the final approval of the grading. Where cut slopes are not subject to erosion due to their rocky character, this requirement may be waived by the Building Official.

An irrigation system or watering facilities may be required by the Building Official.

**Grading Inspection
and Supervision**

Sec. 7016. (a) Supervised Grading Required. All grading in excess of 5000 cubic yards shall be performed under the supervision of a civil engineer and shall be designated "supervised grading." Grading not supervised in accordance with this Section shall be designated "regular grading." For grading involving less than 5000 cubic yards the permittee may elect to have the grading performed as either supervised grading or regular grading.

(h) **Regular Grading Requirements.** The Building Official shall inspect the work, and require adequate inspection and compaction control by a soils testing agency. The soils testing agency shall be approved by the Building Official.

Periodic reports certifying the compaction or acceptability of all fills shall be required except as exempted by Section 7012 (a). These shall include but need not be limited to inspection of cleared areas and benches prepared to receive fill and removal of all soil and unsuitable materials; the placement and compaction of fill materials; the bearing capacity of the fill to support structures, and the inspection or review of the construction of retaining walls, subdrains, drainage devices, buttress fills, and other similar measures.

The Building Official may require sufficient inspection to assure that all geologic conditions have been adequately considered. Where geologic conditions warrant, the Building

Official may require periodic geologic reports. These inspections may be required to include, but need not be limited to inspection of cut slopes, canyons during clearing operations for ground water and earth material conditions; benches prior to placement of fill; and possible spring locations.

**Grading Inspection
and Supervision
(Continued)**

(c) **Supervised Grading Requirements.** For supervised grading it shall be the responsibility of the civil engineer to supervise and coordinate all site inspection and testing during grading operations. Soils and geology reports shall also be required as specified in Section 7017 (b). All necessary reports, compaction data, and soils engineering and engineering geological recommendations shall be submitted to the Building Official by the supervising civil engineer.

(d) **Notification of Noncompliance.** If in the course of fulfilling his responsibility under this Chapter, the supervising civil engineer finds that the work is not being done in conformance with this Chapter or the plans approved by the Building Official, or in accordance with accepted practices, he shall immediately notify the person in charge of the grading work and the Building Official in writing of the nonconformity and of the corrective measures to be taken.

Sec. 7017. If at any stage of the work the Building Official determines by inspection that further grading as authorized is likely to endanger any private property or result in the deposition of debris on any public way or interfere with any existing drainage course, the Building Official may require, as a condition to allowing the work to be completed, that such reasonable safety precautions be taken as he considers advisable to avoid such likelihood of danger.

Safety Precautions

Notice to comply shall be submitted to the permittee in writing. After a notice to comply is written, a period of 10 days shall be allowed for the contractor to begin to make the corrections, unless an imminent hazard exists, in which case the corrective work shall begin immediately.

If the Building Official finds any existing conditions not as stated in the grading permit or approved plans, he may refuse to approve further work until approval is obtained for a revised grading plan which will conform to the existing conditions.

Sec. 7018. (a) Compliance with Plans and Requirements. All permits issued hereunder shall be presumed to include the provision that the applicant, his agent, contractors or employees, shall carry out the proposed work in accordance with the approved plans and specifications and in compliance with all the requirements of this Chapter.

**Responsibility
of Permittee**

(b) **Protection of Utilities.** During grading operations the permittee shall be responsible for the prevention of damage to any public utilities or services. This responsibility applies

within the limits of grading and along any routes of travel of equipment.

(c) **Protection of Adjacent Property.** The permittee is responsible for the prevention of damage to adjacent property and no person shall excavate on land sufficiently close to the property line to endanger any adjoining public street, sidewalk, alley, or other public or private property without supporting and protecting such property from settling, cracking, or other damage which might result.

Modification of Approved Plans

Sec. 7019. All modifications of the approved grading plans must be approved by the Building Official. All necessary soils and geological reports shall be submitted with the plans.

No grading work in connection with the proposed modifications will be permitted without the approval of the Building Official. If, in the opinion of the Building Official, the strict enforcement of Section 7007 (d) 1 will create an undue hardship on the permittee, or a hazard to the safety of operations, this requirement may be waived. Such a waiver shall not relieve the permittee of responsibility for compliance with the design standards of this Code.

Modifications which affect basic tract design or land use must have the approval of the appropriate control agency.

Completion of Work

Sec. 7020. (a) Final Reports. Upon completion of the work, the Building Official may require the following reports:

1. The supervising civil engineer shall certify that all grading, lot drainage, and drainage facilities have been completed in conformance with the approved plans and this Chapter, and shall furnish a final contour map of the completed work.
2. The soils engineering reports shall include certification of soil bearing capacity, summaries of field and laboratory tests, locations of tests, and shall show limits of compacted fill on an "as built" plan.
3. The engineering geology reports shall be based on the final contour map and shall include specific approval of the grading as affected by geological factors. Where necessary, a revised geologic map and cross sections, and any recommendations regarding building restrictions or foundation setbacks shall be included.

(b) **Notification of Completion.** The permittee or his agent shall notify the Building Official when the grading operation is ready for final inspection. Final approval shall not be given until all work including installation of all drainage structures and their protective devices, has been completed and the final contour map and required reports have been submitted.

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