U. S. DEPARTMENT OF COMMERCE

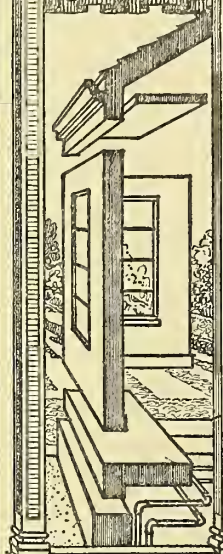
# BUILDING MATERIALS AND STRUCTURES

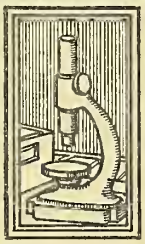
REPORT BMS88

## Recommended Building Code Requirements for New Dwelling Construction

With Special Reference to War Housing

Report of
Subcommittee on Building Codes
Central Housing Committee on
Research, Design, and Construction





NATIONAL
BUREAU OF STANDARDS

## BUILDING MATERIALS AND STRUCTURES REPORTS

On request, the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., will place your name on a special mailing list to receive notices of new reports in this series as soon as they are issued. There will be no charge for receiving such notices.

An alternative method is to deposit with the Superintendent of Documents the sum of $5, with the request that the reports be sent to you as soon as issued, and that the cost thereof be charged against your deposit. This will provide for the mailing of the publications without delay. You will be notified when the amount of your deposit has become exhausted.

If 100 copies or more of any report are ordered at one time, a discount of 25 percent is allowed.

Send all orders and remittances to the *Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.*

The following publications in this series are available by purchase from the Superintendent of Documents at the prices indicated:

| | | |
|---|---|---|
| BMS1 | Research on Building Materials and Structures for Use in Low-Cost Housing | 10¢ |
| BMS2 | Methods of Determining the Structural Properties of Low-Cost House Constructions | 10¢ |
| BMS3 | Suitability of Fiber Insulating Lath as a Plaster Base | 10¢ |
| BMS4 | Accelerated Aging of Fiber Building Boards | 10¢ |
| BMS5 | Structural Properties of Six Masonry Wall Constructions | 15¢ |
| BMS6 | Survey of Roofing Materials in the Southeastern States | 15¢ |
| BMS7 | Water Permeability of Masonry Walls | 10¢ |
| BMS8 | Methods of Investigation of Surface Treatment for Corrosion Protection of Steel | 10¢ |
| BMS9 | Structural Properties of the Insulated Steel Construction Company's "Frameless-Steel" Constructions for Walls, Partitions, Floors, and Roofs | 10¢ |
| BMS10 | Structural Properties of One of the "Keystone Beam Steel Floor" Constructions Sponsored by the H. H. Robertson Co | 10¢ |
| BMS11 | Structural Properties of the Curren Fabrihome Corporation's "Fabrihome" Constructions for Walls and Partitions | 10¢ |
| BMS12 | Structural Properties of "Steelox" Constructions for Walls, Partitions, Floors, and Roofs Sponsored by Steel Buildings, Inc | 15¢ |
| BMS13 | Properties of Some Fiber Building Boards of Current Manufacture | 10¢ |
| BMS14 | Indentation and Recovery of Low-Cost Floor Coverings | 10¢ |
| BMS15 | Structural Properties of "Wheeling Long-Span Steel Floor" Construction Sponsored by the Wheeling Corrugating Co | 10¢ |
| BMS16 | Structural Properties of a "Tilecrete" Floor Construction Sponsored by Tilecrete Floors, Inc | 10¢ |
| BMS17 | Sound Insulation of Wall and Floor Constructions | 10¢ |
| Supplement to BMS17, | Sound Insulation of Wall and Floor Constructions | 5¢ |
| BMS18 | Structural Properties of "Pre-Fab" Constructions for Walls, Partitions, and Floors Sponsored by the Harnischfeger Corporation | 10¢ |
| BMS19 | Preparation and Revision of Building Codes | 15¢ |
| BMS20 | Structural Properties of "Twachtman" Constructions for Walls and Floors Sponsored by Connecticut Pre-Cast Buildings Corporation | 10¢ |
| BMS21 | Structural Properties of a Concrete-Block Cavity-Wall Construction Sponsored by the National Concrete Masonry Association | 10¢ |
| BMS22 | Structural Properties of "Dun-Ti-Stone" Wall Construction Sponsored by the W. E. Dunn Manufacturing Co | 10¢ |
| BMS23 | Structural Properties of a Brick Cavity-Wall Construction Sponsored by the Brick Manufacturers Association of New York, Inc | 10¢ |
| BMS24 | Structural Properties of a Reinforced-Brick Wall Construction and a Brick-Tile Cavity-Wall Construction Sponsored by the Structural Clay Products Institute | 10¢ |
| BMS25 | Structural Properties of Conventional Wood-Frame Constructions for Walls, Partitions, Floors, and Roofs | 15¢ |
| BMS26 | Structural Properties of "Nelson Pre-Cast Concrete Foundation" Wall Construction Sponsored by the Nelson Cement Stone Co., Inc | 10¢ |
| BMS27 | Structural Properties of "Bender Steel Home" Wall Construction Sponsored by the Bender Body Co | 10¢ |
| BMS28 | Backflow Prevention in Over-Rim Water Supplies | 10¢ |
| BMS29 | Survey of Roofing Materials in the Northeastern States | 10¢ |
| BMS30 | Structural Properties of a Wood-Frame Wall Construction Sponsored by the Douglas Fir Plywood Association | 10¢ |
| BMS31 | Structural Properties of "Insulite" Wall and "Insulite" Partition Constructions Sponsored by The Insulite Co | 15¢ |

[List continued on cover page III]

UNITED STATES DEPARTMENT OF COMMERCE · Jesse H. Jones, Secretary
NATIONAL BUREAU OF STANDARDS · Lyman J. Briggs, Director

# BUILDING MATERIALS *and* STRUCTURES

## REPORT BMS88

## Recommended Building Code Requirements for New Dwelling Construction

With Special Reference to War Housing

Report of Subcommittee on Building Codes
Central Housing Committee on Research, Design, and Construction

ISSUED SEPTEMBER 25, 1942



UNITED STATES GOVERNMENT PRINTING OFFICE · WASHINGTON · 1942
FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. · PRICE 20 CENTS

# Foreword

Building code requirements are frequently criticized on the ground that they call for excessive amounts of materials and discourage the introduction of new methods of construction. Such criticism is pointless unless improved requirements can be offered that will have the effect of correcting the conditions mentioned. In this report a representative committee, drawn from the Federal agencies most concerned with housing, presents its recommendations for such improved requirements. The intent is to assure safety and health and at the same time permit the greatest possible flexibility in design and construction. The recommended requirements cover single- and two-family houses and multiple dwellings of limited height.

LYMAN J. BRIGGS, *Director.*

# Recommended Building Code Requirements

# for

# New Dwelling Construction

## With Special Reference to

## War Housing

Report of Subcommittee on Building Codes of the Central Housing Committee on Research, Design, and Construction


Horace W. Peaslee, *Chairman*
(Secretary, Central Housing Committee)

Mary Fidelia Taylor, *Secretary*

George N. Thompson, *Technical Adviser*
(National Bureau of Standards)

Rollo H. Britten for
C-E. A. Winslow,
U. S. Public Health Service.

George R. Callis, Jr.,
Bureau of Yards and Docks (Navy).

Tirrell J. Ferrenz and
Bruce E. Clark,
Federal Home Loan Bank Board.

Luther M. Leisenring and
Charles M. Foster,
Office of Chief of Engineers (War).

William V. Reed and
Ernest H. Olsen,
Division of Defense Housing Coordination.

Bert M. Thorud and
Louis Grandgent,
United States Housing Authority.

Howard P. Vermilya and
W. V. VanCott,
Federal Housing Administration.

Henry H. Waples,
Public Buildings Administration and
War Production Board.



ABSTRACT

A series of recommended requirements suitable for use in building codes is presented. These requirements apply to single- and two-family houses and to multiple dwellings of limited height. They cover such matters as fire resistance, light and ventilation, exits, strength of construction, and chimneys and fireplaces. In general, good practice is required, certain well-recognized standards and specifications being cited as acceptable evidence of good practice. Specific dimensions and other details are given where necessary. The report contains an appendix in which additional information is given, including methods of meeting specific code provisions and references to source material.

# CONTENTS

*For explanation of paragraph numbering, see Appendix, paragraph preceding par. 100.

## INTRODUCTION

The suggested building code requirements for dwellings that appear in this report have been prepared by a committee representing Federal agencies concerned with various aspects of housing. The project was initiated at the suggestion of the Division of Defense Housing Coordination which felt that such an undertaking would have an immediate value in connection with problems growing out of the emergency and might be expected to carry its influence over into more normal times. It suggested that a committee of the Central Housing Committee be established with instructions to review the situation and adjust any conflicting viewpoints on specific requirements.

The procedure employed in the work was first to segregate and compare typical existing requirements, then to consider these in the light of standards developed by the several housing agencies and of information supplied by research, and finally to draft requirements representing the composite judgment of the committee members. Many valuable suggestions were received from various governmental agencies. Standards of private agencies interested in good construction also provided much helpful material.

The committee recognizes that emergency conditions limit the availability of certain materials, require stringent economy in the use of others, and make the use of substitutes necessary in some cases. It is of the opinion, however, that it is not practicable to write building code requirements in terms of a severely restricted list of materials based on temporary shortages nor to suggest details about substitutes in the code itself. Such matters are covered more flexibly and efficiently by general provisions in the code, supplemented by regulations that can be put into effect or withdrawn in accordance with fluctuating conditions. Similarly, it has been found best to treat the subject of new materials and methods of construction in a general way, providing for acceptance on submittal of satisfactory evidence that they are suitable.

In general, the committee favors simplicity of treatment where building code requirements are presented. To this end, it has relied upon references to many standards of public and private agencies where inspection demonstrated that details were satisfactorily treated in such standards. It has also presented as appendix matter various acceptable ways of meeting the code requirements in order to conserve space in the code itself and to widen the field of choice of materials and methods.

One point regarding these requirements deserves special emphasis. Such requirements can be legally effective only when they call for the minimum that is necessary for safety and health. This places them in a different class from other standards, which properly take into consideration expected life, comfort, livability, good taste, and other matters that are socially and economically desirable but cannot be legally required. An appreciation of the distinction should help to clear up some of the confusion that exists regarding apparent inconsistencies between building standards and building code requirements.

The committee wishes to express its appreciation to the many governmental agencies that have responded freely to requests for information and advice. Many individuals within the organizations represented on the committee have been consulted on special problems and have made very helpful suggestions. Special acknowledgment is made to the Forest Products Laboratory of the United States Department of Agriculture and to the National Bureau of Standards of the United States Department of Commerce. Mention should also be made of the close cooperation extended by other committees of the Central Housing Committee, including those on Definitions, Design Standards, and Fire Resistance Classifications. The suggestions of the last-named committee have been especially helpful.

The report is presented as suitable for recommendation where advice is sought of Federal agencies as to proper building code requirements in areas not now having such requirements. It is also offered for consideration wherever local building code requirements are being adopted or revised. It is believed that such a document can provide a continuing service through which the experience of Federal agencies and the results of Federal research can be made continuously available to local governmental authorities. Periodical revision is planned; and criticism and suggestions for improvement are invited.

## CHAPTER I. GENERAL*

### Section 100. Scope

The requirements of this Code apply to dwellings hereafter erected, not over 2½ stories in height when containing 1 or 2 dwelling units, and not over 2 stories in height when containing more than 2 dwelling units; and also to minor accessory structures, such as garages.

### Section 101. Temporary Permits

It shall be unlawful to construct or add to a dwelling or other structure in violation of the provisions of this Code; except that dwellings or other structures not conforming in all respects to this Code may be approved by the building official under a special permit issued by the building official, authorizing him to require their demolition or removal at the expiration of 1 year. Such permit may be extended for 1 additional year or for 1 year after the termination of a legally declared national emergency at the discretion of the building official. For the purpose of determining the adequacy of the dwelling or other structure constructed under such permit, the building official may accept the certification of any Federal housing agency that the dwelling or other structure is deemed adequate for its intended purpose and is necessary in the public interest. (See Appendix, par. 101.)

### Section 102. Materials and Methods not Specifically Authorized

Materials and methods of construction not specifically authorized by this Code may be approved for use by the building official on submittal of evidence satisfactory to him that such use will result in safe construction at least equivalent to that required by this Code.[1] [2] For the purpose of determining safety, the building

*Note.—In municipalities and areas where there is no building code, it is recommended that the procedure concerning powers and duties of the building official, method of obtaining permits, and other administrative matters be governed by the proposed Administrative Requirements for Building Codes being developed by a committee of the American Standards Association, except as this procedure may be modified by this chapter. (See Appendix, par. 100.)

See footnotes 1 and 2 on page 8.

official may require submittal of drawings, methods of analysis, test data, or any other information necessary to reach a decision.

Newly developed materials and methods of construction for which specific requirements are not given in this Code shall not be used until the building official has issued regulations fixing the practices to be followed, but no such regulation shall have the effect of increasing the working stresses for any material mentioned in this Code or of reducing the fire-resistive, fire-protective, or health features of the Code. (See Appendix, par. 102.)

### Section 103. Second-Hand Materials

Second-hand materials may be used provided they comply in quality to requirements for materials in this Code. Masonry units shall be thoroughly cleaned before reusing. Structural members shall not be reused if so affected by previous use as to impair their usefulness for the purpose intended.

### Section 104. Private Water and Sewage-Disposal Systems

Prior to occupancy, a certificate of inspection to indicate compliance with acceptable requirements shall be obtained by the owner or his agent from the State or local health official having jurisdiction in the case of all water and sewage-disposal systems not municipally owned and operated. Except as may be otherwise provided in law, in this Code, or in duly promulgated regulations, the provisions of Parts I and II of the Sanitation Code for State or Local Adoption, of the United States Public Health Service, shall be deemed to be acceptable practice. (See Appendix, par. 104.)

## CHAPTER II. DEFINITIONS

For the purpose of this Code, the terms listed below shall have the meanings given in this chapter.

[1] In addition to its general application, this provision will apply with particular force during the war emergency to the use of substitute materials mentioned in the Defense Housing Critical List to take the place of metals and other critical materials.

[2] Attention is called to the fact that in the Administrative Requirements for Building Codes referred to in the note at the foot of p. 7, provision is made for appeal to a board of appeals in case there is dissatisfaction with the action of the official.

*Alley* means a narrow supplementary thoroughfare for the public use of vehicles and pedestrians affording access to abutting property.

*Approved*, as applied to a material, device, mode of construction, or testing agency, means approved by the building official under the provisions of this Code, or by other authority designated by law to give approval in the matter in question.

*Area*, as applied to the dimensions of a building, means the maximum horizontal area of the building at finished grade, exclusive of unroofed porches, terraces, steps, and areaways.

*Basement* means that portion of a building between floor and ceiling partly underground, but having less than half its clear height below the adjoining finished grade. When 50 percent or more of the floor area of a basement is occupied for human habitation, it shall be counted as a story.

*Bearing partition.* (See *Partition, Bearing.*)

*Bearing wall.* (See *Wall, Bearing.*)

*Building* means an enclosed structure having exterior or party walls and a roof, designed for the shelter of persons, animals, or property.

*Building official* means the officer or other person charged with the administration and enforcement of this Code or his duly authorized representative.

*Cavity wall.* (See *Wall, Cavity.*)

*Cellar* means that portion of a building between floor and ceiling partly underground, but having half or more than half of its clear height below the adjoining finished grade.

*Common property line* means a line dividing one lot from another.

*Concrete, Plain.*—"Plain concrete" means concrete cast in place without metal reinforcement or reinforced only for shrinkage or temperature changes.

*Concrete, Reinforced.*—"Reinforced concrete" means concrete in which reinforcement, other than that provided for shrinkage or temperature changes, is embedded in such a manner that the two materials act together in resisting forces.

*Court* means an open, unoccupied space bounded on two or more sides by the exterior walls of a building or by exterior walls and lot lines.

*Court, Height.*—"Height," as applied to a court, means the vertical distance from the level of the floor of the lowest story containing habitable rooms served by that court to the top of the walls bounding the court. In case the tops of such walls are at different elevations, the measurement shall be taken to the average elevation of the two highest walls that are opposite.

*Court, Inner.*—An "inner court" is a court enclosed on all sides by exterior walls of a building or by exterior walls and lot lines on which walls are allowable.

*Court, Length.*—"Length," as applied to an *outer* court, means the mean horizontal distance between the open and closed ends of the court.

*Court, Outer.*—An "outer court" is a court enclosed on not more than three sides by exterior walls of a building or by exterior walls and lot lines on which walls are allowable, with one side or end open to a street, driveway, alley, or yard.

*Court, Width.*—"Width", as applied to an *inner* court, means its least horizontal dimension. Width, as applied to an *outer* court, means the shortest horizontal dimension measured in a direction substantially parallel with the principal open end of such court.

*Dead load.* (See *Load, Dead.*)

*Dwelling* means a building designed or occupied as the living quarters for one or more families or households, usually equipped with cooking, bathing, toilet, and, where necessary, heating facilities.

*Dwelling unit* means a dwelling or a portion thereof providing complete living facilities for one family.

*Faced wall.* (See *Wall, Faced.*)

*Fire-division wall.* (See *Wall, Fire-division.*)

*Fire door* means a door construction consisting of door, frame, and sill, which under approved fire-test conditions meets the requirements for the location in which it is to be used.

*Fire partition.* (See *Partition, Fire.*)

*Fire resistance* means the period of resistance to standard exposure under the standard fire test. (See Appendix, par. 800.)

*Fire wall.* (See *Wall, Fire.*)

*Grade.*—"Grade," when used in connection with *lumber* for structural purposes, is a classification with respect to strength and suitability for use as a structural member.

*Grade, Finished.*—"Finished grade" means the line formed at the junction of a building and the area immediately surrounding the building to which the ground is to be or has been cut or filled.

*Grade, Natural.*—"Natural grade" means the surface of the ground prior to excavation.

*Habitable room* means a room occupied by one or more persons for living, sleeping, eating, or cooking, and includes kitchens serving a dwelling unit but does not include bathrooms, water-closet compartments, laundries, serving and storage pantries, corridors, cellars, attics, and spaces that are not used frequently or during extended periods.

*Half story.* (See *Story, Half.*)

*Height, Building.*—"Height," as applied to a *building*, means the vertical distance from the finished grade at the principal entrance of the building to the highest point of such building exclusive of chimneys, penthouses, parapets, and ornamental features.

*Height, Court.* (See *Court, Height.*)

*Height, Story.*—"Height," as applied to a *story*, means the vertical distance from the surface of a floor to the surface of the next floor above.

*Height, Wall.*—"Height," as applied to a *wall*, means the vertical distance to the top measured from the foundation wall, or from a girder or other immediate support of the wall.

*Hollow wall.* (See *Wall, Hollow.*)

*Incombustible.*—"Incombustible," as applied to a material, means that the material will not of and by itself ignite when its temperature and that of the surrounding air is 1,200° Fahrenheit (649° C.).

*Lintel* means a structural member supporting masonry above an opening in a wall or partition.

*Load, Dead.*—"Dead load" means the weight of walls, floors, roofs, partitions, and other permanent portions of the structure.

*Lot* means a portion or parcel of land considered as a unit, devoted to a certain use or occupied by a building or a group of buildings that are united by a common interest or use, and the customary accessories and open spaces belonging to the same.

*Lot line* means a line dividing one lot from another, or from a street or other public space.

*Masonry* means stone, brick, structural clay tile, concrete masonry units, gypsum tile or block, structural glass block, or other similar building units or materials, or a combination of same, bonded together with mortar. Masonry also includes plain concrete.

*Multiple dwelling* means a dwelling containing separate dwelling units for three or more families, with joint services or facilities or both.

*Nonbearing partition.* (See *Partition, Nonbearing.*)

*Nonbearing wall.* (See *Wall, Nonbearing.*)

*Occupied* shall be construed as though followed by the words "or intended, arranged, or designed to be occupied."

*Panel wall.* (See *Wall, Enclosure.*)

*Partition, Bearing.* "Bearing partition" means a partition which supports any vertical load in addition to its own weight.

*Partition, Fire.* "Fire partition" means a wall or partition which subdivides a story of a building to restrict the spread of fire or to provide an area of refuge.

*Partition, Nonbearing.* "Nonbearing partition" means a partition which supports no load other than its own weight.

*Party wall.* (See *Wall, Party.*)

*Pier* means an isolated column of masonry; a bearing wall not bonded at the sides into associated masonry and whose length does not exceed four times its thickness shall be considered a pier.

*Plain concrete.* (See *Concrete, Plain.*)

*Property line, Common.* (See *Common property line.*)

*Reinforced concrete.* (See *Concrete, Reinforced.*)

*Room, Habitable.* (See *Habitable room.*)

*Shaft* means an enclosed shaftway or space, extending through one or more stories of a building, connecting a series of two or more openings in successive floors, or floors and roof.

*Spandrel wall.* (See *Wall, Spandrel.*)

*Standard fire test* means the fire-test procedure formulated and published by the American Society for Testing Materials under the title of "Standard Specifications for Fire Tests of Building Construction and Materials." (See Appendix, par. 800.)

*Story* means that part of a building comprised between a floor and the floor or roof next above wherein 75 percent or more of the clear floor area has the minimum height established for habitable rooms. (See *Basement.*)

*Story, Half.*—A "half story" is one wherein less than 75 percent of the clear floor area under the roof next above has the minimum height established for habitable rooms. An unfinished space immediately under a roof of a multiple dwelling shall not be considered a half story.

*Street* means a highway or thoroughfare dedicated or devoted to public use by legal mapping, user, or other lawful manner; and includes avenue, road, alley, lane, boulevard, terrace, concourse, driveway, and sidewalk.

*Structure* means a combination of materials forming a construction having more or less permanent location.

*Veneered wall.* (See *Wall, Veneered.*)

*Wall, Bearing.*—A wall which supports any vertical load in addition to its own weight.

*Wall, Cavity.*—A wall built of masonry units or of plain concrete, or a combination of these materials, so arranged as to provide a continuous air space within the wall from bottom to top, and in which the inner and outer parts of the wall are tied together with metal ties.

*Wall, Common-property-line.*—A wall along a property line against which a wall can be built on the adjoining property.

*Wall, Enclosure.*—An exterior nonbearing wall between columns or piers and supported at each story.

*Wall, Faced.*—A wall in which the masonry facing and backing are so bonded as to exert common action under load.

*Wall, Fire.*—A wall, whose strength is dependent upon incombustible materials, which subdivides a building or separates buildings to restrict the spread of fire, by starting at the foundation and extending continuously through all stories to or above the roof.

*Wall, Fire-division.*—A wall which subdivides a building to restrict the spread of fire, but is not necessarily continuous through all stories nor extended through the roof.

*Wall, Hollow.*—A wall built of solid masonry units so arranged as to provide an air space within the wall, bonding between separate vertical withes being effected by the same

masonry units used in the wall construction so that the withes exert common action under load.

*Wall, Nonbearing.*—A wall which supports no vertical load other than its own weight.

*Wall, Panel.* (See *Wall, Enclosure.*)

*Wall, Party.*—A wall used jointly by two parties under easement agreement and erected at or upon a line separating two parcels of land that may be held under different ownership.

*Wall, Spandrel.*—A part of a wall between the top of a window or door of one story and the sill of a window or door above.

*Wall, Veneered.*—A wall having a facing which is not attached and bonded to the backing so as to form an integral part of the wall for purposes of load bearing and stability.

*Yard, Front.*—A yard across the full width of the lot, extending from the front line of the building to the front line of the lot.

*Yard, Rear.*—A yard across the full width of the lot, extending from the rear line of the building to the rear line of the lot.

*Yard, Side.*—A yard extending from the front yard or front lot line to the rear yard or rear lot line, from the side line of the building to the side lot line.

## CHAPTER III. FIRE-RESISTANCE CLASSIFICATIONS

### Section 300. General

For the purpose of this Code, construction shall be classified into four different types which shall be limited as to height, ground-floor area, and location, and in other respects as required elsewhere in this Code. (See Appendix, par. 300.)

### Section 301. Types of Construction

#### *1. Fireproof*

"Fireproof construction" means that in which structural members, including partitions, are of incombustible materials having a fire resistance sufficient to withstand the fire severity resulting from complete combustion of the contents. The minimum fire resistance of structural members shall be as follows:

| | Hours |
|---|---|
| Exterior walls—outside exposure: | |
| Distance from a common property line or other structures: | |
| Under 10 feet (including common-property-line walls) | 2 |
| From 10 to 20 feet | 1½ |
| More than 20 feet | 1 |
| Fire walls, fire-division walls, and party walls | 2 |
| Fire partitions | 1 |
| Interior bearing walls | 1 |
| Columns, girders, trusses | 1 |
| Floor construction | 1 |
| Roof construction | 1 |

provided that unprotected combustible or incombustible roof construction may be used over an unusable attic space if the ceiling and the construction below the attic are of incombustible materials having a fire resistance not less than that specified for floor construction.

Roof coverings shall conform to Class 1, Class 2, or Class 3 coverings if over incombustible sheathing, and to Class 1 or Class 2 coverings if over combustible construction, as defined in Section 804.

#### *2. Incombustible*

Incombustible construction is that in which the exterior walls, bearing walls, floor and roof construction, and other structural members are of incombustible materials. Fire walls shall have a fire resistance of at least 2 hours; party walls and common-property-line walls shall have a fire resistance of at least 1½ hours. Unprotected combustible roof construction and sheathing may be used over unusable spaces if protected beneath by a ceiling and supporting construction of incombustible materials having a fire resistance of at least ½ hour. Roof coverings shall conform to Class 1, Class 2, or Class 3, as defined in Section 804.

#### *3. Exterior-Protected*

Exterior-Protected construction means that in which exterior walls are ground supported and of masonry or other incombustible construction. Interior framing is partly or wholly of wood or other similar materials. The mini-

mum fire resistance of structural members shall be as follows:

| | Hours |
|---|---|
| Exterior walls—outside exposure: | |
| Distance from a common property line or other structures: | |
| Under 10 feet | 2 |
| From 10 to 20 feet | 1½ |
| Over 20 feet | 1 |
| Party and common-property-line walls: | |
| At and below a framed first floor | 2 |
| Elsewhere | 1½ |
| Fire walls: | |
| At and below a framed first floor | 3 |
| Elsewhere | 2 |

Roof coverings shall conform to Class 1 or Class 2 when the dwelling or other structure is 12 feet or less from another building or other structure or from a common property line. They shall meet requirements of Class 1, Class 2, or Class 3 when more than 12 feet from such buildings, other structures, or lot lines.

### *4. Wood-Frame*

Wood-Frame construction means that in which exterior walls are wholly or partly of wood or other combustible materials, including construction having an incombustible exterior veneer. Fire walls, party walls, and common-property-line walls shall have the following minimum fire resistance:

| | Hours |
|---|---|
| Fire walls: | |
| At and below a framed first floor | 3 |
| Elsewhere | 2 |
| Party and common-property-line walls: | |
| At and below a framed first floor | 2 |
| Elsewhere | 1½ |

Roof coverings shall meet the requirements of Class 1, 2, 3, or 4 in Section 804, provided that when the dwelling or other structure is more than 12 feet from an adjacent dwelling or other structure or from a common property line, Class 5 roofing may be used.

### Section 302. Doubtful Classifications

In case there is doubt as to the classification within which a given dwelling or other structure falls, the building official shall determine such classification.

### Section 303. Partial Compliance

Nothing in this Code shall require full compliance with a type of construction, if, under this Code, a less restricted form of construction is permitted; but no dwelling or other structure shall be deemed to be of a given type of construction unless it conforms with all specific provisions of this Code applying to that type.

## CHAPTER IV. GENERAL BUILDING RESTRICTIONS

### Section 401. Zoning Restrictions

Nothing in this Code shall be construed to lower in any way existing zoning requirements. If the requirements of this Code exceed existing zoning requirements, then this Code shall govern.

### Section 402. Limitations

### *1. Height*

No dwelling or other structure of Type 4 Wood-Frame construction shall exceed 40 feet or 2½ stories at any point above finished grade.

### *2. Area*

The ground-floor area of dwellings or groups of attached dwellings of Type 2 Incombustible or Type 3 Exterior-Protected construction shall not exceed 4,500 square feet unless separated by fire walls into areas none of which exceeds 4,500 square feet. Within each area of 4,500 square feet there shall be not more than 6 dwelling units: provided that in multiple dwellings there shall be not more than 8 dwelling units, 4 to a floor if the floor construction between stories has a fire resistance of 1 hour.

The ground-floor area of a dwelling or of a group of attached dwellings of Type 4 Wood-Frame construction shall not exceed 3,000 square feet unless separated by fire walls into areas none of which exceeds 3,000 square feet. Within each ground-floor area of 3,000 square feet there shall be not more than 4 dwelling units.

Where a floor is over a basement or crawl space and is of fireproof construction or where it consists of a concrete slab laid on the ground,

the ground-floor area and the number of dwelling units between fire walls, or either, may be increased by 50 percent.

### 3. Building Lines

Except as specifically permitted in law or regulations, no dwelling or other structure shall be so located that any part extends beyond established building lines.

### Section 403. Party Walls [3]

Party walls shall be designed as bearing walls capable of carrying safely any loads which may be imposed from both sides; and shall be so constructed that a dwelling unit on either side may be razed without impairment of structural stability of the wall. (See ch. III and sec. 801–2.)

## CHAPTER V. LIGHT AND VENTILATION

### Section 500. General

For the purpose of providing adequate light and ventilation, every building shall be constructed, arranged, and equipped to conform to the provisions of this chapter.

### Section 501. Rooms

### 1. Habitable Rooms

(*a*) *Minimum area.*—Living rooms shall have an area not less than 150 square feet, or not less than 160 square feet when dining space is included and not less than 220 square feet when dining and cooking space is included, provided that this area shall be not less than 210 square feet when located in a dwelling unit having less than two bedrooms.

The area of kitchens shall be not less than 60 square feet, or not less than 90 square feet when dining space is included, provided that the area of the kitchen shall be not less than 50 square feet when located in a dwelling unit having less than two bedrooms.

The area of at least one bedroom shall be not less than 100 square feet.

The area of any other habitable room shall be not less than 70 square feet.

The minimum areas required above are exclusive of storage and closet space.

(*b*) *Minimum height.*—Habitable rooms shall have a clear height of not less than 7 feet 6 inches, provided that rooms in half stories shall have a clear height of 7 feet 6 inches in at least one-half their area. In computing the area of rooms in half stories, all portions less than 5 feet in height shall be disregarded.

(*c*) *Minimum width.*—Habitable rooms, except kitchens, shall be not less than 7 feet in width.

(*d*) *Number of windows.*—Every habitable room shall have one or more windows conforming to the requirements of this chapter.

(*e*) *Rooms below finished grade.*—No room which has less than 50 percent of its height above the average adjoining finished grade shall be occupied as a habitable room.

### 2. Bathrooms and Water-Closet Compartments

Every bathroom and every water-closet compartment shall have one or more windows or, when immediately under a roof, may have a ventilating skylight, conforming to the requirements of this chapter.

### 3. Privacy

When a bathroom is provided, the following requirements shall apply:

When there are several bedrooms, at least two bedrooms shall have access to a bathroom without passing through another habitable room. Every bedroom shall have access to a bathroom without passing through another bedroom. Every habitable room shall have access to every other habitable room without passing through a bedroom.

No bathroom shall open directly into a kitchen. No bathroom shall provide sole access to any other room. No bathroom in a base-

[3] The municipality or agency using this Code should examine the statutes, ordinances, or other regulations pertaining to party walls in the community for correlation therewith. The recommendations in this Code incorporate only minimum requirements considered essential to health and safety to life. Some authorities contend that the mutuality of ownership inherent in a party wall should impose additional construc tion requirements. Presented below is the suggested wording for a code requirement based on this contention:

Party walls shall be of masonry; they shall bear on foundations of the same type and construction as exterior wall foundations; they shall extend to the underside of the roof sheathing.

ment shall serve as the only bathroom for a living unit above.

### Section 502. Windows

#### *1. Arrangement* [4]

Every window required by this Code shall open directly on a street, alley, yard or court, or an approved open space equivalent to a yard or court conforming to the requirements of this chapter.

The tops of windows providing required glass area shall be not more than 1 foot below the finished ceiling unless they are at least 7 feet above the finished floor.

#### *2. Glass Area*

The aggregate glass area of windows or other glazed openings required or permitted by this chapter shall be not less than the following (see Appendix, par. 502):

For habitable rooms, 1/10 of the floor area served by the windows or openings, but not less than 12 square feet except for kitchens, which shall have not less than 9 square feet (see Appendix, par. 502–2);

For bathrooms and water-closet compartments, 1/10 of the floor area served, but not less than 3 square feet;

For basements and cellars, 1/50 of the floor area served.

#### *3. Openable Area* [5]

The aggregate openable area of windows or other glazed openings required or permitted by this chapter shall be not less than the following:

For habitable rooms, 50 percent of the required glass area;

For bathrooms and water-closet compartments, 50 percent of the required glass area, but not less than 3 square feet;

For basements and cellars, the entire required glass area.

#### *4. Screening*

When deemed necessary by the local health authorities, dwellings shall be effectively screened. (See Appendix, par. 502–4.)

[4] It is recommended that windows be so located as to provide as even a distribution of light as possible throughout habitable rooms.

[5] It is recommended that consideration be given to requiring cross or through ventilation in all dwelling units. (See Appendix, par. 502–2.)

### Section 503. Ventilating Skylights

Skylights permitted by this chapter shall have glass area not less than that required for windows they replace. They shall be arranged with the sides extended above the roof and there provided with hinged glazed sash having an area not less than that required for openable parts of windows, or they may be arranged with fixed incombustible louvered sides having the required openable area and a pivoted glazed sash at the ceiling line.

### Section 504. Yards

#### *1. Rear Yards*

Every dwelling shall have a rear yard not less than 20 feet in depth. For each foot of height that the wall located along the rear yard exceeds 15 feet above the average finished grade, the depth of such yard shall be increased not less than 4 inches.

In the case of an irregular lot or where the wall of a dwelling is not parallel to the lot line, the required minimum depth of a rear yard may be deemed to be the average depth (measured perpendicular to the building wall), provided that no such rear yard shall be less in depth than 15 feet at any point. This minimum shall be increased 4 inches for each foot of height that the wall located along the rear yard exceeds 15 feet above the average finished grade.

In computing the depth of a rear yard for any dwelling when the rear of such yard opens on an alley, one-half the width of such alley may be assumed to be a portion of the yard.

#### *2. Side Yards*

Each side yard shall have a width of not less than 5 feet, provided that 4 inches shall be added for each foot of height that the wall located along the yard exceeds 15 feet above the average finished grade.

In the case of an irregular lot or where a wall of a dwelling is not parallel to the lot line, the required minimum width of a side yard may be deemed to be the average width (measured perpendicular to the wall of the dwelling), provided that no such side yard shall be less in width than 3 feet at any point. This minimum shall be increased 4 inches for each foot of

height that the wall located along the side yard exceeds 15 feet above the average finished grade.

*3. Unobstructed*

Every yard shall remain unobstructed for its required width or depth and full height, except that cornices projecting not more than 12 inches into the required width or depth, ordinary window sills or belt courses projecting not more than 4 inches into the required width or depth, and drop awnings, shall not be considered obstructions. Clothes poles, arbors, uncovered porches, steps, terraces, garden trellises, and similar accessories are not prohibited by this requirement.

Section 505. Courts

*1. Width*

Every outer court serving habitable rooms shall have a width of not less than 5 feet nor less than 1 foot for each 3 feet or fraction thereof in height.

Every inner court serving habitable rooms shall have a width of not less than 10 feet nor less than 1 foot for each 1 foot or fraction thereof in height.

Courts shall not be deeper than twice their width.

*2. Area*

The cross-sectional area of an inner court serving habitable rooms shall be not less than one and one-half times the square of its required width.

*3. Unobstructed*

Every court shall remain unobstructed for its required width or depth and full height, except that cornices projecting not more than 12 inches into the required width or depth, ordinary window sills or belt courses projecting not more than 4 inches into the required width or depth, and drop awnings, shall not be considered obstructions. Clothes poles, uncovered porches, steps, terraces, arbors, garden trellises, and similar accessories are not prohibited by this requirement.

*4. Drainage*

The bottom of every court shall be properly graded and drained.

*5. Intakes*

Every court that does not open for its full height on one or more sides on a street or yard shall be connected at or near the bottom with a street or yard by an intake. Such intake shall have a cross-sectional area of not less than 21 square feet and shall remain fully open at both ends and unobstructed for its required size and full length except that grilles, easily opened from the approach side when the intake is used as an exit, may be permitted at the ends.

Section 506. Buildings on the Same Lot

If any dwelling or other structure is placed on the same lot with another building or other structure so that any window of either receives light and ventilation from the space between, the width of such space shall be at least 10 feet. This minimum shall be increased not less than 4 inches for each foot that the wall located along the space exceeds 15 feet above finished grade. The height is to be taken as the average height of the two structures.

## CHAPTER VI. EXITS

Section 600. General

Multiple dwellings shall be provided with exit facilities as provided in this chapter.

Section 601. Kinds of Exits

Exits shall consist of stairways or public hallways and doorways providing direct exit to a street or to an exterior open space leading to a street. Exterior iron fire escapes shall not be considered as required exits.

Section 602. Number of Exits

Every floor of a multiple dwelling and every floor area enclosed by fire and exterior walls shall have not less than two exits; provided that when no entrance door of a dwelling unit is distant more than 20 feet from a door opening into an exit stairway or from the top riser of such stairway, one exit may be permitted.

### Section 603. Location

#### *1. Distance*

Exits shall be so located that the distance from the entrance door of a dwelling unit to an exit shall not exceed 60 feet; provided that no such door located on a dead-end hallway shall be more than 20 feet from an exit.

#### *2. Distribution*

When a floor has two or more exits, they shall be placed as far apart as practicable.

### Section 604. Stairways

#### *1. Width*

No stairway serving as an exit shall have a width of less than 36 inches.

The aggregate width of stairways serving as exits shall be not less than 22 inches for every 30 persons or fraction thereof served by the stairway.[6]

#### *2. Construction*

(*a*) *Materials.*—Stairs and landings of stairways serving as exits shall be constructed of incombustible materials, provided that combustible materials may be used in buildings of Type 3 Exterior-Protected and Type 4 Wood-Frame construction. Stairways shall have solid treads.

(*b*) *Treads and risers.*—Treads and risers of stairs in stairways serving as exits shall be so proportioned that the sum of two risers in inches and the width of one tread in inches is not less than 24 nor more than 25, provided that no riser shall exceed 7¾ inches and no tread shall be less in width than 9½ inches exclusive of nosing.

Winders shall not be used.

Treads and risers shall be of uniform width and height in any one flight.

The minimum headroom of all required stairways shall be 7 feet at every point measured vertically at the riser.

The minimum number of risers in any flight of a required stairway shall be not less than three.

(*c*) *Landings.*—No flight of stairs shall have a vertical rise of more than 12 feet between floors or landings.

The length and width of landings shall be not less than the width of stairways in which they occur.

(*d*) *Handrails.*—Required stairways shall have enclosing walls or well-secured balustrades or guards on both sides and shall be provided with handrails on at least one side. When 44 inches or more in width, they shall have handrails on both sides. Handrails shall project not more than 3½ inches into the width of the stairway.

(*e*) *Enclosures.*—Required stairways and public hallways shall be enclosed with construction having a fire resistance of at least ¾ hour. Stairways extending into basements and cellars shall be provided with approved self-closing metal-clad doors or with wood slab doors of a minimum thickness of 1¾ inches.

No openings except the necessary doorways, and windows opening to the exterior of the building, shall be permitted in enclosures of stairways and hallways serving as exits.

(*f*) *Lighting and ventilation.*—Adequate facilities for artificial lighting shall be provided. When dependence is placed upon natural light, windows containing at least 12 square feet of glass area, or the equivalent of this in glass block or glazed doors, shall be supplied; provided that a stairway of one continuous flight may be lighted by a door on the entrance level having a glass area of at least 10 square feet.

Required stairways shall be provided with ventilating skylights with fixed louvers, windows on an exterior wall glazed with plain glass, or a plain-glass skylight with a metal screen below the glass. The open or openable area in the case of the first two devices shall be at least 6 square feet.

### Section 605. Doorways

#### *1. Width*

No doorway serving as an exit shall have a width of less than 32 inches.

The aggregate width of exit doorways to the outside of a building from lobbies, hallways, or passageways into which exit stairways discharge shall be at least equal to the width of the stairways.

[6] A suggested method of estimating the width of a required stairway is on the basis of 1½ persons for each habitable room in each dwelling unit.

The width of exit doorways at the foot of exit stairways or at the head of exit stairways serving basements shall be at the rate of not less than 20 inches for every 22 inches of stairway width served.

*2. Hanging of Doors*

The doors of doorways serving as exits except exterior doors shall swing in the direction of exit travel and shall be so hung and arranged that they shall not obstruct the travel along an exit passageway, stairway, or other required exit, provided that a door swung flat against a wall is not considered an obstruction and, provided further, that no door shall at any point in its swing reduce the width of an exit stairway by more than 18 inches.

No door of a doorway serving as an exit shall open immediately on a flight of stairs but a landing at least the width of the door shall be provided between such door and such stairs.

Interior doors which provide access to or from a dwelling unit shall not be regarded as exits.

Section 606. Public Hallways

*1. Width*

The width of a public hallway shall be at least equal to the width of the exit doorway to which it leads, but not less than 36 inches.

*2. Enclosure*

Walls, partitions, floors, and ceiling construction enclosing public hallways shall have a fire resistance of not less than that required for the construction in which they occur but not less than 3/4 hour in any case.

*3. Lighting and Ventilation*

Adequate facilities for artificial lighting shall be provided. When dependence is placed on natural light, windows or skylights containing at least one-twentieth of the hallway floor area, or an equivalent area in glass blocks or glazed doors, shall be provided. (See Appendix, par. 606–3.)

Section 607. Modifications in Exit Width

There shall be no reduction in required exit width along the line of exit travel except as specifically permitted in this chapter.

Section 608. Obstructions

No fire-extinguishing apparatus, radiator, steam, or other riser shall be placed in an exit or in a hallway leading to an exit unless placed in such a manner as not to interfere with free travel and unless heating apparatus is guarded by substantial metal screens or is otherwise safeguarded from contact with occupants.

## CHAPTER VII. CONSTRUCTION

Section 700. General

*1. Quality of Materials*

All building materials shall be of good quality, conforming to generally accepted standards. Except as may be otherwise provided in law, or in this Code, or in duly promulgated regulations, the specifications of the American Society for Testing Materials or other generally accepted standards—such as Federal Specifications, standards of the American Standards Association, or Commercial Standards promulgated by the United States Department of Commerce through the National Bureau of Standards—shall be deemed to be generally accepted standards. (See Appendix, par. 700.)

*2. Details and Connections*

All members shall be so framed, tied, and braced as to develop the strength and rigidity necessary for the purposes for which they may be used. No member shall be stressed in excess of the strength of its details and connections.

*3. Design and Workmanship*

Design of structural members, and workmanship in the fabrication and preparation of materials and in their installation, shall conform to generally accepted good practice. Specific provisions of this section shall be controlling but shall not be deemed to suspend other requirements of good practice which shall be regarded as supplementing such specific provisions. Except as may be otherwise provided in law, or in this Code, or in duly promulgated regulations, the standards of Federal or State agencies, national technical organiza-

tions, or fire underwriters shall be deemed to be generally accepted good practice.

### Section 701. Working Stresses

#### *1. General*

Dwellings and other structures shall be so designed that the safe working stresses of the materials used are not exceeded.

#### *2. Increases*

Higher stresses than herein specified may be used, but only if it is clearly established, by test or other satisfactory evidence, that material of a higher grade or a superior workmanship than is generally provided in ordinary good practice is to be employed. The use of higher stresses, however, shall not be allowed until a statement, giving the reasons for such permission together with the facts and circumstances on which it is based, is placed on file and made a part of the official record of the permit.

### Section 702. Loads

#### *1. Design*

All parts of dwellings and other structures shall be designed to support safely their own weight and all other loads to which they may be subjected.

#### *2. Floor, Ceiling, and Roof Loads*

The minimum load to be assumed as caused by the occupancy for design of floors shall be not less than 40 pounds per square foot uniformly distributed, provided that, for upper floors of single-family dwellings, the load may be reduced to 30 pounds in designing floor joists for flexure.

Where attics are to be used for light storage, a live load of not less than 20 pounds per square foot shall be assumed on ceiling joists. Where no provision is made for attic storage, no live load need be assumed on ceiling joists.

The total load to be used in designing girders shall include the dead load of floor, ceiling, and partition constructions plus the combined dead and live load of the roof plus 50 percent of the assumed live loads of floors and ceilings.

An imposed load of not less than 20 pounds per square foot shall be assumed on roofs either flat or pitched.[7] This load shall be on the horizontal projection.

#### *3. Wind Loads*

(*a*) *Unit loads.*—Vertical faces of dwellings and other structures shall be capable of withstanding a horizontal wind load of not less than 20 pounds per square foot, allowing for wind from any direction.

Roofs or sections of roofs with slopes greater than 30 degrees shall be capable of withstanding a wind load of 20 pounds per square foot acting inward normal to the surface, the load to be applied to the windward slope only.

Where construction and provision for anchorage is satisfactory to the building official, submittal of design computations or test data may be waived by him.

(*b*) *Anchorage.*—Adequate anchorage of roofs to walls and columns, and of walls and columns to foundations, shall be provided to resist safely vertical lifting forces and to prevent any sliding or overturning.[8]

### Section 703. Soil-Bearing Capacity

#### *1. Normal Conditions*

The safe carrying capacity of soil may be assumed, for the purposes of this Code, as at least 2 tons per square foot, provided that this shall be modified where necessary in accordance with rulings of the building official on the basis of character and capacity of soil.

#### *2. Varying Soil Conditions*

In case a dwelling or other structure rests partly on rock or hardpan and partly on some other soil, measures shall be taken to equalize settlement.

#### *3. Filled Ground*

No dwelling or other structure shall be placed upon filled ground until the building official has fixed by test or inspection the safe sustaining power that may be assumed.

[7] The load given is to be taken as the absolute minimum and should be increased when necessary to take account of local conditions, including loads caused by snow.

[8] As a specific basis for design of anchorage, a suction or vertical lifting force of 20 pounds per square foot is suggested, assuming 2/3 of the dead load is acting to resist the force.

*4. Clearing of Building Site*

All stumps and roots shall be removed from the soil for a distance of 12 inches around and beneath the space to be occupied by the dwelling or other structure.

*5. Protection of Adjoining Property*

Except as may be otherwise provided in law, excavations made to a depth of 12 feet or less below natural grade shall be so protected that the soil of adjoining property will not cave in or settle, but the expense of underpinning or extending the foundations of buildings or other structures on adjoining properties shall be borne by the adjoining property owner. For excavations in excess of 12 feet below natural grade, all expenses of any nature incurred by the adjoining property owner in protecting his property shall be borne by the party causing the excavation to be made.

Section 704. Foundations

*1. Required*

All dwellings or other structures shall have foundation walls or piers, except when supported by concrete slabs whose design is approved by the building official.

*2. Depth*

Except when erected upon solid rock, foundation walls or piers shall be carried below frost line and not less than 12 inches below natural grade, provided that this requirement shall not apply to structures other than dwellings which are of Type 2 Incombustible or Type 4 Wood-Frame construction not more than one story in height and 400 square feet in area.

*3. Frozen Ground*

No dwelling or other structure shall be built upon frozen ground.

*4. Footings*

(*a*) *Materials.*—Footings of walls, columns, and piers shall consist of plain concrete, reinforced concrete, or solid masonry units when approved by the building official, provided that footings of wood may be used if they are entirely below permanent water level or subjected to a preservative treatment by pressure processing conforming to good practice. Except as may be otherwise provided in duly promulgated regulations, the recommendations of the American Wood-Preservers' Association shall be deemed to be good practice. (See Appendix, par. 704.)

(*b*) *Design.*—Footings of walls, chimneys, piers, and columns shall be of dimensions to maintain a safe load on the soil and shall be so designed that the pressure on the soil per unit of area shall, so far as practicable, be uniform under all parts of the building or structure. Footings shall rest on level solid ground or rock. Whenever excavation for footings is carried below the planned depth, the space so excavated, below the proposed footings, shall be filled solidly with concrete. The maximum projection of a footing shall be one-half of its depth unless reinforcement is provided to resist bending. (See Appendix, par. 704–4.)

*5. Pile Foundations*

Piles intended to sustain walls or buildings shall be of wood, reinforced concrete, steel shells filled with concrete, or other approved types. So far as practicable, they shall be driven to a solid bearing; or they shall be driven to provide adequate support in accordance with good engineering practice. The method of driving shall be such as not to impair their strength.

Wood piles shall be sound and straight timber. Piles and capping timbers or portions thereof, which are not placed below permanent water level, shall be pressure-treated with creosote in conformance with good practice. Except as may be otherwise provided in duly promulgated regulations, the recommendations of the American Wood-Preservers' Association shall be deemed to be good practice. (See Appendix, par. 704.)

Piles and capping timbers or portions thereof may not extend within 12 inches of the ground surface. The safe sustaining power of wood piles shall be determined by an approved formula or by test.

When doubt exists as to the safe sustaining power of piles upon which a dwelling or other

structure is to be supported, the building official may order a test to be made.

### 6. Foundation Walls

(*a*) *General.*—Foundation walls shall be of sufficient strength and thickness to resist lateral pressure from adjacent earth and to support their vertical loads safely.

(*b*) *Thickness.*—In no case shall a foundation wall be less in thickness than the wall immediately above, provided that masonry veneered walls may project not more than ¾ inch beyond the outside face of the supporting wall.

When built of brick masonry, coursed stone, structural clay tile, or concrete masonry units, or when they are hollow walls of solid units, foundation walls shall be not less than 12 inches thick, provided that when such walls do not extend more than 7 feet below the adjacent ground level, or when the area within the foundation walls is not excavated, walls may be 8 inches thick if included within the allowable height of 8-inch walls.

When built of brick masonry reinforced with at least one ⅜-inch round deformed bar, continuous from footing to top of foundation wall, for each 2-foot length of wall, foundation walls shall be at least 8 inches thick.

When built of concrete cast in place, foundation walls shall be at least 8 inches thick, or 6 inches thick for buildings or other structures not exceeding one story in height; provided that if such walls extend more than 7 feet below the adjacent ground, they shall be reinforced in the same manner as described above for reinforced brick masonry, or shall be increased in thickness at least 1 inch for each additional foot of depth.

When built of rubble stone, foundation walls shall be at least 16 inches thick. Rough or random rubble without bonding or level courses shall not be used as foundations for walls exceeding 35 feet in height.

When the character of soil makes it necessary, the building official may require pilasters, buttresses, or additional wall thickness to guard against the result of lateral pressure. He may also require the installation of drain tile around footings to carry ground water away from the structure.

(*c*) *Height above ground.*—Foundation walls supporting wood or light steel structural members shall extend at least 6 inches above the finished grade.

(*d*) *Waterproofing.*—Unless deemed unnecessary by the building official, foundation walls of basements and cellars shall be made watertight.

(*e*) *Drainage.*—When the surface of the ground beneath a building having no basement or cellar is below the outside finished grade, adequate provision shall be made for draining any space beneath the building.

## Section 705. Masonry

### 1. Quality of Materials [9]

(*a*) *Brick—Brick (clay or shale).*—Brick exposed to weather or soil, but not subject to frost action when permeated with water, shall conform to the requirements for grade "MW" brick of the Tentative Specifications for Building Brick (Made from Clay or Shale), ASTM Designation C 62–41T of the American Society for Testing Materials. When exposed to weather or soil and subject to frost action when permeated with water, brick shall conform to the requirements for grade "SW". When not exposed to weather or soil, brick shall conform to the requirements for grade "NW".

*Sand-lime brick.*—Sand-lime brick exposed to weather or soil, but not subject to frost action when permeated with water, shall conform to the requirements for grade "MW" brick of the Standard Specifications for Sand-Lime Building Brick, ASTM Designation C 73–39 of the American Society for Testing Materials. When exposed to weather or soil and subject to frost action when permeated with water, sand-lime brick shall conform to the requirements for grade "SW". When not exposed to weather or soil, sand-lime brick shall conform to the requirements for grade "NW".

*Concrete brick.*—Concrete brick exposed to weather or soil shall conform to the requirements for grade "A" brick of the Standard Specifications for Concrete Building Brick, ASTM Designation C 55–37 of the American Society for Testing Materials. When not exposed to weather or soil, concrete brick shall

[9] See Appendix, par. 705.

conform to the requirements for grade "B" brick.

(*b*) *Structural clay tile.*—Structural clay tile used in party walls or exposed to weather or soil shall conform to the requirements for grade "LBX" tile of the Standard Specifications for Structural Clay Load-Bearing Wall Tile, ASTM Designation C 34–39 of the American Society for Testing Materials.

Structural clay tile used in load-bearing masonry but not exposed to weather or soil shall conform to the requirements for grade "LB" tile of the above specifications.

Structural clay tile used in interior non-load-bearing masonry shall conform to the requirements of the Standard Specifications for Structural Clay Non-Load-Bearing Tile, ASTM Designation C 56–39 of the American Society for Testing Materials.

(*c*) *Concrete masonry units.*—Hollow concrete masonry units used in party walls or in load-bearing masonry or exposed to weather or soil shall conform to the requirements of the Standard Specifications for Hollow Load-Bearing Concrete Masoney Units, ASTM Designation C 90–39 of the American Society for Testing Materials.

Hollow concrete masonry units used in non-load-bearing masonry not exposed to weather or soil shall conform to the requirements of the Standard Specifications for Hollow Non-Load-Bearing Concrete Masonry Units, ASTM Designation C 129–39 of the American Society for Testing Materials.

Solid concrete masonry units shall conform to requirements of Tentative Specifications for Solid Load-Bearing Concrete Masonry Units, ASTM Designation C 145–39T of the American Society for Testing Materials.

(*d*) *Plain concrete.*—Plain concrete other than concrete fill shall have a minimum compressive strength at 28 days of 2,000 pounds per square inch.

The maximum size of concrete aggregates 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 2½ inches.

Water used in mixing concrete shall be clean, and free from deleterious amounts of acids, alkalis, or organic materials.

(*e*) *Stone.*—Stone for masonry shall be sound and durable and free from clay and loose formations.

(*f*) *Gypsum block.*—Gypsum block shall not be used in walls exposed to the weather or to soil.

(*g*) *Mortar.*—Mortars of the following proportions, with the sand measured in a damp loose condition, shall be acceptable for the specific uses mentioned in this section.

| *Type* | *Proportions, by volume* |
|---|---|
| A | 1 part of portland cement to not more than 3 parts of sand, with an addition of hydrated lime or lime putty of not more than 25 percent of the cement. |
| B | 1 part of portland cement, 1 part of hydrated lime or lime putty, and not more than 6 parts of sand.<br>1 part of prepared masonry cement conforming to Type II of Federal Specification SS–C–181B to not more than 3 parts of sand. |
| C | 1 part of portland cement, 2 parts of hydrated lime or lime putty, and not more than 9 parts of sand.<br>1 part of prepared masonry cement to not more than 3 parts of sand. |
| D | 1 part of hydrated lime or lime putty to not more than 3 parts of sand. |

Foundation walls below finished grade of structural clay tile or hollow concrete masonry units shall be laid in Type A mortar. Foundation walls below finished grade of solid masonry units shall be laid in Type A or Type B mortar, provided that Type A mortar shall be used when exposed to frost in the presence of moisture.

Footings and piers shall be laid in Type A or Type B mortar, provided that Type A mortar shall be used when exposed to frost in the presence of moisture.

Load-bearing and exterior walls of structural clay tile or hollow concrete masonry units, and load-bearing or exterior hollow walls of masonry shall be laid in Type A or Type B mortar.

Cavity walls not more than 10½ inches in thickness shall be laid in Type A mortar. Cavity walls more than 10½ inches in thickness shall be laid in Type A or Type B mortar.

Masonry linings of existing walls shall be laid in Type A mortar.

For other masonry, Types A, B, or C mortar may be used, provided that Type C shall not be used where exposed to weather or soil.

Type D mortar of approved quality may be used in solid masonry walls, other than parapet walls, not in contact with the soil and not less than 12 inches thick, provided that the walls are laterally supported at intervals not exceeding 12 times the wall thickness. (See Appendix, par. 705–1.)

### 2. Lateral Support

(*a*) *Solid masonry walls.*—Solid masonry walls shall be supported at right angles to the wall face at intervals not exceeding 20 times the wall thickness.

(*b*) *Walls of hollow units.*—Walls of structural clay tile or hollow concrete masonry units, and hollow walls of masonry shall be supported at right angles to the wall face at intervals not exceeding 18 times the wall thickness.

(*c*) *Cavity walls.*—Cavity walls shall be supported at right angles to the wall face at intervals not exceeding 14 times the wall thickness exclusive of the cavity.

(*d*) *Methods.*—Such lateral support may be obtained by cross walls, piers, or buttresses, when the limiting distance is measured horizontally, or by floors and roof when the limiting distance is measured vertically. Sufficient bonding or anchorage shall be provided between the wall and the supports to resist the assumed wind force, acting either inward or outward. Piers or buttresses relied upon for lateral support shall have sufficient strength and stability to transfer the wind force, acting in either direction, to the ground. When walls are dependent upon floors or roofs for their lateral support, provision shall be made in the building to transfer the lateral forces to the ground.

### 3. Solid Brick Walls

(*a*) *Thickness—bearing.*—Solid brick bearing walls shall be not less than 8 inches thick if not over 35 feet in height, provided that walls of buildings or other structures not exceeding one story in height may be 6 inches thick when built with Type A mortar and not over 9 feet in height. Walls of buildings more than 35 feet in height shall be not less than 8 inches thick for the uppermost 35 feet, below which they shall be 12 inches thick.

(*b*) *Thickness—nonbearing.*—Solid brick nonbearing exterior walls shall be not less than 6 inches thick throughout their height.

(*c*) *Bond.*—In solid brick walls with a masonry bond, there shall be at least one full-length header in every 1½ square feet of wall surface, provided that the distance between adjacent full-length headers shall not exceed 20 inches either vertically or horizontally. In walls more than 12 inches thick, the inner joints of header courses shall be covered with another header course which shall break joints with the course below.

Where running bond is used, at least every seventh course shall be a full header course or each face shall be bonded into the backing by cutting the face-brick course and using diagonal headers behind it or by using a split brick.

### 4. Walls of Hollow Masonry Units

(*a*) *Thickness.*—The minimum thickness of bearing and nonbearing walls of structural clay tile or concrete masonry units shall be not less than that required for solid brick walls of corresponding type.

(*b*) *Bond.*—Hollow masonry units shall have full mortar coverage on vertical and horizontal face shells.

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 34 inches by lapping at least 4 inches over the unit below.

Where walls of hollow masonry units are decreased in thickness, a course of solid masonry shall be interposed between the wall section below such point and that next above.

### 5. Plain Concrete Walls

(*a*) *Thickness—bearing.*—Plain concrete walls shall be not less than 8 inches thick for a height of 35 feet, provided that walls of buildings or other structures not exceeding one story in height may be 6 inches thick when not over 9 feet in height. Walls of buildings over 35 feet in height shall be not less than 8 inches thick for the uppermost 35 feet, below which they shall be 11 inches thick.

(*b*) *Thickness—nonbearing.*—Plain concrete nonbearing walls shall be not less than 6 inches thick throughout their height.

(*c*) *Reinforcement.*—Reinforcement, symmetrically disposed in the thickness of the wall, shall be placed not less than 1 inch above openings, and shall extend not less than 24 inches each side of such openings or be of equivalent length with hooks. The reinforcement shall consist of two ⅝-inch round rods for openings up to 5-foot spans, with two additional ⅝-inch round rods for openings up to 8-foot spans, or their respective equivalents.

At wall junctions or returns two ⅜-inch round rods or their equivalent, bent to the angle of the junction, not less than 12 inches long each side of the bend, shall be spaced not over 20 inches apart in the height of the wall, symmetrically disposed, with at least 1 inch of concrete covering the steel.

### *6. Stone Walls*

(*a*) *Thickness.*—The minimum thickness of walls of stone ashlar shall be not less than that required for solid brick walls.

Rubble stone walls shall be 4 inches thicker than is required for solid brick walls of the same respective heights, but in no case less than 16 inches.

(*b*) *Bond.*—Bond stones extending through the wall and uniformly distributed shall be provided to the extent of not less than 10 percent of the area, and there shall be at least one bond stone for every five stretchers.

### *7. Hollow Walls of Solid Units and Cavity Walls*

(*a*) *Height.*—Hollow walls of solid masonry units and cavity walls shall not exceed 35 feet in height above the tops of foundation walls.

(*b*) *Thickness.*—The minimum thickness of hollow walls of solid masonry units shall be not less than 8 inches.

The minimum thickness of cavity walls, exclusive of the cavity, shall be not less than that required for walls of the material which forms the inner part of the wall, with a tolerance of ½ inch. Cavity walls formed of two nominal 4-inch withes shall not exceed 25 feet in height. Neither the outer nor the inner part of a cavity wall shall be less than 3¾ inches thick, and the distance between inner and outer parts of the wall shall be not less than 2 inches nor more than 3 inches.

(*c*) *Bond.*—The inner and outer parts of hollow walls of solid masonry units shall be securely tied together with headers so that the parts of the wall will exert common action under the load, but in no case shall there be more than 4 courses of masonry units when laid on edge, nor more than 6 courses when laid flatwise, between header courses.

Where hollow walls of solid masonry units are decreased in thickness, a course of solid masonry shall be interposed between the wall section below such point and that next above.

The inner and outer parts of cavity walls shall be securely tied together with suitable bonding ties of adequate strength. Ties shall be steel rods coated with portland cement grout or other approved protective coating, or a noncorroding metal. A 3/16-inch diameter steel rod or its equivalent shall be used for each 3 square feet of wall surface. The ends of the ties shall be bent to 90-degree angles to provide hooks not less than 2 inches long and shall be embedded in a horizontal joint of each withe.

For walls constructed of hollow units, ties shall consist of bars bent to the shape of a rectangle with the ends butted (not welded) on one side and lying in the mortar bed of the withe with each end of the tie lying over at least one web of units; or they shall consist of welded steel wire in strips of two longitudinal wires lying in mortar beds of both withes and cross wire equivalent to the ties specified for rectangular shapes.

Additional bonding ties shall be provided at all openings, spaced not more than 3 feet apart around the perimeter of the opening and within 12 inches of the edge of the opening. Cavity walls shall be flashed so as to lead moisture to the outside through weep holes provided for the purpose. Cavity walls of plain concrete shall be reinforced as provided in Section 705–5 (c).

### *8. Veneered Masonry Walls*

(*a*) *Materials.*—Materials used for veneering shall be not less than 3 inches in thickness,

provided that thinner material may be used when approved by the building official.

In stone ashlar, each stone shall have a reasonably uniform thickness, but all stones need not necessarily be of the same thickness.

(*b*) *Loading.*—In no case shall veneering be considered a part of the required thickness of bearing walls.

(*c*) *Attachment of veneer.*—The veneering shall be tied into the backing either by a header for every 300 square inches of wall surface or by substantial, noncorrodible metal wall ties spaced not farther apart than 1 foot vertically and 2 feet horizontally. Headers shall project at least 3¾ inches into the backing. When veneering is used, special care shall be taken to fill all joints flush with mortar around openings. Slab terra cotta, flat tile, or other thin veneering shall also be solidly cemented to the masonry backing.

### *9. Faced Walls*

(*a*) *Materials.*—Materials used in the backing and facing of faced walls shall conform in all respects to the requirements prescribed for such materials in Section 705–1. Materials used for facing shall be not less than 2¼ inches thick, and in no case less in thickness than ⅛ the height of the unit.

(*b*) *Thickness.*—Faced walls shall be not less in thickness than is required for masonry walls of the type which forms the backing.

(*c*) *Bond.*—Brick facing shall be bonded to walls of brick, of structural clay tile, or of concrete masonry units, with at least one full-length header in every 1½ square feet of wall surface.

Stone ashlar facing shall have at least 20 percent of the superficial area not less than 3¾ inches thicker than the remainder of the facing to form bond stones, which shall be uniformly distributed throughout the wall.

When some stones in every alternate course are at least 7½ inches thick, bonded into the backing at least 3¾ inches, and at least 20 percent of the superficial area of the wall is constituted of such bond stones uniformly distributed, the ashlar facing may be counted as part of the wall thickness. Every stone not a bond stone and every projecting stone shall be securely anchored to the backing with substantial noncorrodible metal anchors with a cross section of not less than 0.2 square inch or other approved anchors. There shall be at least one anchor to each stone and not less than two anchors for each stone more than 2 feet in length and 3 square feet in superficial area. Facing stones not over 12 square feet in area shall have at least one anchor to each 4 square feet of superficial face area.

### *10. Piers*

(*a*) *Height.*—The unsupported height of piers shall not exceed 10 times their least dimension.

(*b*) *Size.*—Piers shall be not less than 8 inches by 16 inches or 12 inches by 12 inches for unit masonry and not less than 10 inches by 10 inches or 12-inch diameter for plain concrete.

(*c*) *Hollow isolated piers.*—Structural clay tile or hollow concrete masonry units shall not be used for isolated piers to support girders or beams unless solidly filled with concrete, but no increase in loading shall be permitted because of such filling; provided that unfilled hollow piers may be used if their unsupported height is not more than 4 times their least dimension. Unfilled hollow piers shall be built solid at their tops to a depth of at least 4 inches unless they support concrete slabs.

### *11. Openings in Walls or Partitions*

Openings shall not be permitted in walls or partitions separating dwelling units.

### *12. Parapet Walls*

(*a*) *Thickness.*—Parapet walls shall be at least as thick as the top-story walls which support them, except that they need not in any case be more than 8 inches thick.

(*b*) *Height.*—Parapet walls shall be at least 6 inches high, but shall be not higher than 4 times their thickness unless laterally supported. When reinforced both horizontally and vertically with not less than ¼-inch rods spaced not more than 2 feet on centers, the height of parapet walls may be not more than 6 times their thickness.

### *13. Spandrel Walls*

Spandrel walls shall be not less in thickness than that required for nonbearing walls of the

kind of material used, provided that this thickness may be reduced to 4 inches when backed with ½ inch of incombustible insulating material.

### *14. Partitions*

(*a*) *Bearing.*—All interior bearing walls, except fire walls and fire-division walls, are considered as bearing partitions.

Bearing partitions shall be of sufficient thickness to support their vertical loads safely, but not less than as required in Section 705–2.

(*b*) *Nonbearing.*—Nonbearing partitions of masonry shall be built solidly against floor and ceiling construction below and above, and the thickness, exclusive of plaster, shall be not less than 2 inches for a maximum unsupported height of 9 feet; provided that nonbearing masonry partitions having an unsupported height greater than 9 feet and not more than 12 feet, shall be 3 inches thick exclusive of plaster.

### *15. Miscellaneous Requirements*

(*a*) *Bonding at intersections.*—Masonry walls shall be securely anchored and bonded at points where they intersect and where they abut or join the frame of a skeleton-frame building.

Cast-in-place concrete slabs bearing on masonry walls shall be considered as sufficient anchorage for the supporting walls.

(*b*) *Chases and recesses.*—There shall be no chases in walls that are 8 inches or less in thickness or within the required area of any pier; and no chase in any wall or pier shall be deeper than one-third the wall thickness, provided that a chase not exceeding 4 inches wide and 4 inches deep may be built for a height of 8 feet into an 8-inch wall of a single- or two-family detached or semidetached dwelling if any space not otherwise occupied is filled with incombustible insulating material. No horizontal chase shall exceed 4 feet in length, nor shall the horizontal projection of any diagonal chase exceed 4 feet in length.

Recesses for radiators and similar appliances may be built into a wall, provided the wall is not reduced below 4 inches in thickness and is backed with ½ inch of incombustible insulating material.

Except as permitted above, no chases or recesses shall be permitted in any wall that will reduce the fire resistance of such wall below the minimum specified in this Code.

The aggregate area of recesses and chases in any wall shall not exceed one-fourth the whole area of the face of the wall in any story.

Chases and recesses shall not be cut in solid 8-inch walls or in hollow walls, cavity walls, or walls of hollow masonry units, but may be built in.

(*c*) *Lintels and arches.*—The masonry above openings and recesses shall be supported by arches or lintels of steel or of plain or reinforced masonry, which shall bear on the wall at each end for not less than 4 inches and shall be supported as required for concentrated loads. Stone or other nonreinforced masonry lintels shall not be used unless supplemented on the inside of the wall with iron or steel lintels or with suitable masonry arches carrying the masonry backing.

Steel or reinforced masonry lintels shall be of sufficient strength to carry the superimposed load without deflection of more than one three-hundred-sixtieth of the clear span.

Masonry arches shall be designed to carry the superimposed load. Proper provision shall be made for resisting lateral thrust. (See Appendix, par. 705–15(c).)

(*d*) *Separation of combustible structural members.*—A separation of at least 4 inches of solid masonry shall be provided in all walls between combustible members which may enter from opposite sides.

When unprotected-steel or combustible structural members frame into hollow walls of thickness not greater than 12 inches, they shall project not more than 4 inches into the wall and shall be so spaced that there shall be a distance of at least 4 inches between the ends of such members entering from opposite sides of the wall. The space above, below, and between such members shall be filled solidly with burnt-clay materials, mortar, concrete, or equivalent fire-resistive material, to a depth of not less than 4 inches on all sides of the members.

All open cells in tiles or blocks occurring at wall ends shall be filled solidly with concrete for a depth of at least 6 inches, or closure tiles set in the opposite direction shall be used.

(*e*) *Concentrated loads.*—Beams, joists, girders, and other structural members producing concentrated loads on walls or piers shall have bearings at least 3 inches in length upon solid masonry not less than 4 inches thick. Metal bearing plates of adequate design and dimensions, but not less than 5/16 inch thick, may be used.

(*f*) *Cornices.*—The centers of gravity of stone cornices shall be inside the outer wall face. Terra-cotta or metal cornices shall be structurally supported.

### *16. Existing Walls*

No existing wall shall be used for renewal or extension of a building, or be increased in height, without special written permission from the building official.

### *17. Erection*

(*a*) *Protection.*—All masonry shall be protected against freezing for at least 48 hours after placing. Unless adequate precautions against freezing are taken, no masonry shall be built when the temperature is below 32 degrees Fahrenheit on a rising temperature or below 40 degrees on a falling temperature, at the point where the work is in progress. No frozen materials shall be built upon. In hot dry weather, adequate precautions shall be taken to prevent too rapid drying.

(*b*) *Support on wood.*—No masonry wall construction shall be supported on wood girders or other form of wood construction.

(*c*) *Nailing blocks.*—No timber, except nailing blocks not exceeding an ordinary brick in size, shall be built in as a part of masonry walls; but this shall not preclude the use, on exterior walls, for decorative purposes only, of timber members against the masonry or set into the masonry to no greater extent than permitted in this Code for chases.

## Section 706. Reinforced Concrete

### *1. General*

Except as may be otherwise provided in law, in this section, or in duly promulgated regulations, the Building Regulations for Reinforced Concrete of the American Concrete Institute as adopted and amended from time to time shall be deemed to be generally accepted good practice. (See Appendix, par. 706.)

### *2. Mix*

Concrete for reinforced concrete shall consist of 1 part of portland cement to not more than 6 parts of aggregate, either in the proportion of 1 part of cement, 2 parts of sand, and 4 parts of coarse aggregate measured dry by volume, and not more than 7½ gallons of water per sack of 94 pounds of cement; or in such other proportion that the crushing strength at 28 days shall be not less than 2,000 pounds per square inch.

### *3. Walls*

(*a*) *Anchoring.*—Enclosure walls of reinforced concrete shall be securely anchored at all floors. Such walls when supported by girders at each story shall be bonded or otherwise securely tied to columns or piers.

(*b*) *Thickness.*—Bearing walls shall be not less than 6 inches in thickness for the uppermost 12 feet of their height and shall be increased 1 inch for each successive 25 feet or fraction thereof measured downward. They shall have a thickness of at least one twenty-fifth of the unsupported height or length, whichever is the shorter, provided that approved buttresses, built-in columns, or piers designed to carry all the vertical loads may be used in lieu of increased thickness.

Panel and enclosure walls shall have a thickness of not less than 5 inches and not less than one-thirtieth the distance between the supporting or enclosing members.

Exterior basement and cellar walls, foundation walls, and fire walls shall be not less than 8 inches thick, provided that foundation walls of one-story buildings may be 6 inches.

### *4. Protection of Reinforcement*

(*a*) *Footings.*—The reinforcement in footings shall be covered on all sides by not less than 3 inches of concrete wherever such footings come in contact with the ground.

(*b*) *Structural members.*—The reinforcement in columns, girders, and beams shall be covered on all sides by not less than 1½ inches of concrete.

### 5. Protection

When the temperature of the surrounding air is less than 40° Fahrenheit, the concrete shall be heated and protected for as much time as is necessary to insure proper curing. In hot dry weather, adequate precautions shall be taken to prevent too rapid drying.

### 6. Working Stresses

(*a*) *Allowable stresses.*—For concrete of the grade provided for in this section the working stresses, in pounds per square inch, in reinforced concrete construction shall be taken as follows:

| | |
|---|---|
| Extreme fiber of concrete, in compression (flexure) | 900 |
| Concrete in direct compression | 500 |
| Concrete in shear | 40 |
| Bond between concrete and steel | 80 |
| Bond between concrete and approved deformed bars | 100 |

For steel reinforcement, in tension:

| | |
|---|---|
| Intermediate and hard grade | 20, 000 |
| Structural grade | 18, 000 |
| Cold-drawn steel wire | [10] 20, 000 |

(*b*) *Increased stresses.*—When evidence acceptable to the building official is submitted that the concrete or reinforcing steel to be provided will be of greater unit strength, the above working stresses may be increased in accordance with generally accepted good practice. (See sec. 706–1.)

### 7. Removal of Forms

Forms for reinforced concrete shall remain in place until the concrete has hardened. Those parts of the forms and shoring that support structural members shall not be removed until such members have acquired sufficient strength to support safely their own weight and such loads as may come upon them during construction operations. All forms and other temporary woodwork which are near to or in contact with the concrete or the soil shall be removed when the construction is completed.

## Section 707. Reinforced Brick Masonry

Reinforced brick masonry shall conform to generally accepted good practice. Except as may be required in law, in this Code, or in duly promulgated regulations, the requirements of Chapter 13 of Principles of Brick Engineering, 1939, published by Structural Clay Products Institute, shall be deemed to be generally accepted good practice. (See Appendix, par. 707.)

All mortar for reinforced brick masonry shall be Type A. (See sec. 705–1 (g).)

[10] May be increased to 30,000 under conditions specified in Building Regulations for Reinforced Concrete of the American Concrete Institute.

## Section 708. Steel and Iron

### 1. General

Except as may be otherwise provided in law, in this section, or in duly promulgated regulations, the Specification for the Design, Fabrication and Erection of Structural Steel for Buildings of the American Institute of Steel Construction shall be deemed to be generally accepted good practice. (See Appendix, par. 708.)

### 2. Working Stresses

(*a*) *Structural and rivet steel.*—Working stresses, in pounds per square inch, for structural steel shall not exceed the following values:

| | |
|---|---|
| *Tension:* | |
| Structural steel, net section | 20, 000 |
| Rivets, on area based on nominal diameter | 15, 000 |
| *Compression:* | |
| Columns, gross section | |
| For axially loaded columns with values of $l/r$ not greater than 120 | $17,000-0.485\frac{l^2}{r^2}$ |
| For axially loaded columns with values of $l/r$ greater than 120 | $\frac{18,000}{1+\frac{l^2}{18,000\ r^2}}$, |
| in which $l$ is the unbraced length of the column and r is the corresponding radius of gyration of the section, both in inches. | |
| Plate girder stiffeners, gross section | 20, 000 |
| Webs of rolled sections at toe of fillet | 24, 000 |
| *Bending:* | |
| Tension on extreme fibers of rolled sections, plate girders, and built-up members | 20, 000 |
| Compression on extreme fibers of rolled sections, plate girders, and built-up members, for values of $l/b$ not greater than 40 | $\frac{22,500}{1+\frac{l^2}{1,800\ b^2}}$ |
| with a maximum of | 20, 000 |
| in which $l$ is the laterally unsupported length of the member, and b is the width of the compression flange, both in inches. | |
| Stress on extreme fibers of pins | 30, 000 |

| | | |
|---|---|---|
| *Shearing:* | | |
| Rivets | | 15, 000 |
| Pins, and turned bolts in reamed or drilled holes | | 15, 000 |
| Unfinished bolts | | 10, 000 |
| Webs of beams and plate girders, gross section | | 13, 000 |
| *Bearing:* | *Double shear* | *Single shear* |
| Rivets | 40, 000 | 32, 000 |
| Turned bolts in reamed or drilled holes | 40, 000 | 32, 000 |
| Unfinished bolts | 25, 000 | 20, 000 |
| Pins | 32, 000 | |
| Contact area: | | |
| Milled stiffeners and other milled surfaces | 30, 000 | |
| Fitted stiffeners | 27, 000 | |
| Expansion rollers and rockers (pounds per linear inch) | | 600*d* |
| in which *d* is diameter of roller or rocker in inches. | | |

(*b*) *Cast steel.*—Compression and bearing same as for structural steel. Other allowable stresses, 75 percent of those for structural steel.

### *3. Light Steel Construction*

Steel studs, or other steel structural members of hot-rolled or cold-formed steel, other than steel joists, having less thickness than called for in the specifications referred to in Section 708–1 may be used either alone or in combination with other materials provided they are designed in accordance with generally accepted good practice and are capable of supporting all loads, including wind loads, without exceeding allowable working stresses. Working stresses for members of steel equal in quality to structural steel shall be the same as for that material. For members of steel different in quality, working stresses shall be modified as required by the building official. (See Appendix, par. 708.)

### *4. Steel Joists*

Except as may be otherwise provided in law, in this section, or in duly promulgated regulations, the Standard Specifications for Steel Joists of the Steel Joist Institute shall be deemed to be generally accepted good practice for design and installation of steel joists. When required by the building official, design computations, test results, or other information shall be supplied sufficient to establish the safety of the construction. (See Appendix par. 708.)

Field welding shall be done only when approved by the building official. (See Appendix, par. 708.)

### *5. Miscellaneous Requirements*

(*a*) *Thickness.*—The minimum thickness of all steel members in exposed places, including crawl spaces, shall be not less than 16 gage.

(*b*) *Protection.*—Steel studs, joists, and all other steel members shall be given one shop coat of approved paint. All exposed members shall be given a second coat in the field.

## Section 709. Wood Construction

### *1. General*

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

Except as may be otherwise provided in law, in this section, or in duly promulgated regulations, the principles set forth in the Wood Handbook of the United States Department of Agriculture shall be deemed to be good practice in the design of wood construction.

Adequate nailing shall be provided at the intersections of wood structural members and at other points specifically designated in this section. (See Appendix, par. 709–1.)

### *2. Determination of Required Sizes*

Unless otherwise designated, the sizes given in this section are nominal. American Lumber Standard dressed sizes shall be accepted as the minimum net sizes conforming to nominal sizes.[11] 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 finished sizes exceeding American Lumber Standard dressed sizes are to be used, computations may be predicated on such actual sizes, provided they are specified

[11] See Simplified Practice Recommendation R16-39, Lumber: American Lumber Standards for Softwood Lumber, promulgated by the U. S. Department of Commerce through the National Bureau of Standards. (See Appendix, par. 709–2.)

on the plans, or in a statement appended thereto. For convenience, nominal sizes may be shown on the plans.

### 3. Working Stresses [12]

The allowable working stresses for all species and grades shall be based on evaluation of the effect of knots, and on the limitations of decay, slope of grain, shakes, checks, splits, wane, and moisture content, in accordance with the principles set forth in Miscellaneous Publication 185, Guide to the Grading of Structural Timbers (February 1934), of the United States Department of Agriculture, and May 1940 Supplement thereto issued by the Forest Products Laboratory. (See Appendix, par. 709–3.)

Working stresses due to the dead and live loads, acting singly or in combination, but without wind or other loads of short duration, shall not exceed the allowable stress permitted for the respective species and grade. For stresses produced by wind or other lateral loads of short duration or by combination of wind loads and dead and live loads, the allowable stresses herein permitted may be increased 50 percent, provided the resulting sections are not less than those required for dead and live loads alone. The values for modulus of elasticity shall be taken without change under any condition of load.

Shearing stress for joint details may be taken as 50 percent greater than the horizontal-shear values otherwise permitted.

In joists supported on a ribbon board and spiked to the studding, the allowable stress in compression perpendicular to the grain may be increased 50 percent.

### 4. Posts

Wood posts when used as columns in basements or cellars shall bear on concerete bases extending not less than 3 inches above the finished floor. The base shall bear directly on the post footing. When the floor is not of concrete or other solid material impervious to termites, concrete bases for wood posts shall be not less than 6 inches above the finished floor.

[12] Tables of working stresses containing specific values consistent with these general requirements will be found in par. 709–3 of the Appendix.

### 5. Splicing

Structural framing members shall not be spliced between bearing points unless approved by the building official.

### 6. Exterior Walls

(*a*) *Load-carrying capacity.*—Exterior walls shall be designed to carry safely all loads as specified in Section 702. (See Appendix, par. 709–6 (a).)

(*b*) *Sheathing.*—Exterior walls not having diagonal wood sheathing shall have diagonal bracing at all corners. Such other measures shall be taken to secure rigidity as may be necessary.

Wood sheathing boards shall be not less than 6 inches in width and shall be nailed to each stud, using not less than two eightpenny nails to each stud for boards up to 8 inches wide and three nails for wider boards. Other forms of sheathing shall be nailed as required by the building official. (See Appendix, par. 709–1.)

Sheathing shall be nailed to top and bottom plates and to sills. (See Appendix, par. 709–1.)

In frame construction of 2 or 2½ stories where the studs are not continuous from sill to roof and diagonal sheathing is omitted, other sheathing or connections shall be provided so designed as to supply adequate structural continuity between first and second stories to resist lateral pressures.

(*c*) *Masonry veneer on Wood-Frame construction.*—Masonry veneer applied to the walls of frame construction shall rest directly upon the masonry foundation of the structure and shall be not less than 3¾ inches in thickness.

Corrosion-resistant flashing shall be installed when necessary to prevent moisture from penetrating behind the veneer.

Masonry veneer shall be securely attached to the frame structure, at intervals of not more than 16 inches vertically and 24 inches horizontally, with noncorrodible nails or ties.

A waterproof covering [13] shall be securely attached to the framework of the structure back of the masonry veneer.

(*d*) *Stucco on Wood-Frame construction.*—Corrosion-resistant flashing or other expedients

[13] For best results, a covering should be used that permits the passage of moisture in the form of vapor from the inside to the outside.

that will prevent penetration of moisture behind the stucco shall be used wherever necessary.

Where sheathing is omitted, approved corner and wall bracing shall be used. If a wall is back-plastered, the plaster shall be of sufficient thickness to extend back between the studs a distance of not less than ¼ inch. (See Appendix, par. 709–6 (d).)

Metal reinforcement, when used, shall be of expanded metal fabric weighing not less than 1.8 pounds per square yard or of wire fabric weighing not less than 20 pounds per 100 square feet, and having openings not less than ¾ inch nor more than 2 inches in greatest dimension. Where sheathing is omitted, the weight of such metal reinforcement or mesh shall be not less than 3.4 pounds per square yard.

Metal reinforcement for stucco of any type shall be furred away from sheathing or building paper at least ⅜ inch at all points by the use of approved furring nails or devices or by suitable metal strips unless self-furring metal lath is used.

The thickness of stucco when applied on metal lath or similar reinforcement shall be at least 1 inch and the metal reinforcement shall be covered on the exposed face at least ⅝ inch.

(*e*) *Ribbon boards.*—Ribbon boards used to support joists shall be not less than 1 by 4 inches, shall be cut into the studs, and securely nailed with not less than two tenpenny nails to each stud. The ends of joists adjoining studs shall be securely spiked to the studs. Wood blocking shall be inserted at the ends of joists not adjoining studs.

(*f*) *Notching of studs.*—In bearing walls or partitions, no stud shall be cut more than one-third its depth to receive piping and duct work or for other purposes. If more depth is required, the width of studs shall be increased accordingly.

(*g*) *Plates.*—Plates in exterior walls used to support joists or rafters shall be double, with each piece not less than 2 inches thick and the same width as the supporting studs.

(*h*) *Framing over openings in bearing walls.*[14]—Lintels and trusses in 2- by 4-inch bearing stud walls shall have heights and spans designed in accordance with good engineering practice, provided that no lintel shall be less than the equivalent of two 2- by 4-inch members on edge.

(*i*) *Jambs in bearing walls.*—All window and door openings in bearing walls shall have studs doubled on jambs. Such studs may be separated when effectively blocked to act as a unit. The inner stud may be cut to receive the lintel or header over the opening but shall extend in one piece from lintel or header to bearing.

### 7. Interior Partitions

(*a*) *Load-carrying capacity.*—Walls shall be designed to carry safely the full dead and live loads. (See Appendix, par. 709–6 (a).)

(*b*) *Plates.*—In 2- by 4-inch stud construction the bearing partitions shall be provided at the top with double plates, each at least 2 inches thick and of the same width as the studs. When the joists are placed directly above each stud, a single top plate may be used, provided that joints in the plate are properly spliced to form a continuous tie and the ends are tied to adjacent walls. If properly firestopped, studs may run through the floor and rest on girders or on partition plates.

Partitions not resting upon girders or on partition plates below shall have sole plates of dimensions not less than that of the studs.

Partitions unsupported by walls shall be supported on girders or double joists or on sole plates if placed at an angle to the joists.

Nonbearing partitions of 2- by 4-inch stud construction shall be provided with at least one 2-inch plate on top and bottom of same width as the studs or be otherwise properly firestopped at floor lines.

(*c*) *Framing over openings in bearing partitions.*—Framing over openings in bearing partitions shall conform to the requirements in Section 709–6 (h) for framing over openings in bearing walls.

### 8. Floors and Roofs

(*a*) *Joists and girders.*—When supported by masonry, joists shall have ample bearing but not less than 3 inches.

[14] These requirements are based entirely on structural considerations. Attention should also be given to possible shrinkage effects due to the depth of the member. Where excessive shrinkage is indicated, resort should be had to trussing or other methods. (See Appendix, par. 709–6 (h).)

Each tier of floor joists entering masonry walls shall be securely anchored thereto to resist safely a lateral force equal to the assumed wind pressure. Such anchorage may consist of T-shaped steel anchors attached to every fourth joist but not more than 6 feet apart.

The ends of joists shall be beveled and anchors shall be so attached that the joists will be released from the walls in case of fire.

Joists running parallel to enclosing walls shall be anchored to the walls to resist safely a lateral force equal to the assumed wind pressure. Anchors shall be spaced not more than 8 feet apart and shall extend back and engage at least three joists.

When enclosing walls are of wood, each joist, beam, and girder in the wall shall be securely spiked or anchored to the wall construction, so as to stay in place and to resist safely all lifts and lateral pressures required to be assumed by this Code.

Girders shall be fastened to each other where they intersect or abut, so as to resist safely a lateral force equal to the assumed wind pressure.

Floor joists framing into the side of wood girders shall be supported on metal joist hangers or on a bearing strip or ledger board on the side of the girders. Such strips or boards shall measure at least 2 by 3 inches. The notch in the end of the joist shall be not more than one-fourth of the joist depth, and the shearing stress shall not exceed the allowable stress when calculated in accordance with good engineering practice.

The ends of joists, whether resting upon girders or bearing partitions or abutted against the girders, shall be securely tied to the girders or to each other, so as to resist safely an outward thrust on the walls equal to the assumed wind pressure or the spreading action of the roof, whichever is the greater.

All joints of solid and built-up wood girders shall be made over column or pier supports.

Joists supporting nonbearing partitions which are parallel to the joists shall be doubled.

When nonbearing partitions weighing more than 120 pounds per linear foot are not parallel to joists, the joist size shall be increased over that required for normal loading or the joist spacing shall be decreased. Where the partition is located at or within 1 foot of the center of the span, the joist size shall be that required for a span 2 feet greater than the actual span. For other positions of the partition, the size of the joist may be uniformly decreased to the size required for ordinary loading when the partition is over the joist supports.

Joists shall not be notched within the middle one-half of the span. The top and bottom edges of joists may be notched in the outer one-quarter of the length, provided the notch does not exceed one-sixth of the joist depth.

(*b*) *Headers and trimmers.*—Design of headers and trimmers shall conform to good engineering practice.

All headers and trimmers shall be doubled except headers receiving not more than three tail beams and trimmers receiving a header with only one tail beam not over one-sixth of the joist span from the support. (See Appendix, par. 709–8 (b).)

(*c*) *Support of rafters.*—Rafters shall be vertically supported near the ridge when the slope is less than 4 inches per foot. Rafters, regardless of slope, shall be thus supported unless they are held from spreading. If the spread of the rafters is held by ties not at the plate line, the size of rafters shall be increased to take care of the additional bending moments induced by the ties when the roof is loaded with the maximum vertical load. (See Appendix, par. 709–8 (c).)

Wood rafters shall be so spiked, or otherwise fastened to the plate or other members as to resist safely all thrusts under full load and the upward lift, but not less than the equivalent of two sixteenpenny nails to each rafter end shall be used. (See Appendix, par. 709–1.)

If the rafters rest upon partitions as in a one-and-one-half-story house, these partitions shall be considered as load bearing and the floor joists shall be increased in size to take care of that part of the roof load carried by the partitions.

(*d*) *Bridging.*—Floor and flat-roof joists and beams shall be securely bridged at intervals not exceeding 8 feet. (See Appendix, par. 709–8 (d).)

### 9. *Plank-and-Beam Construction* [15]

(*a*) *Design.*—Plank-and-beam construction shall conform to good engineering practice. (See Appendix, par. 709–9.)

(*b*) *Beams.*—The spacing of beams, center to center, shall in no case exceed 52 times the actual thickness of the plank. Beams shall be not less than 3 inches, nominal dimension, thick nor have a depth-width ratio more than 4 based on actual dimensions. When beams are built of two or more laminations, the depth-width ratio of a single lamination shall not exceed 6 based on actual dimensions.

Floor beams shall not be notched unless additional section is provided. Beams shall not bear over doors or windows without special provision for their support.

(*c*) *Plank.*—Plank shall be 2 inches or more in thickness and 6 inches or more in width, nominal dimensions, and shall be tongue-and-groove or splined.

Well-seasoned plank, with a moisture content close to that which it would reach in service, shall be used. The plank shall be laid at right angles to the supporting beams and shall be both blind- and surface-nailed. Planks which are continuous over two spans, or single-span planks which are distributed so that they do not occur in adjacent positions, may be used on spans not exceeding 52 times the actual thickness of the plank. Where it is necessary to have single-span planks in adjacent positions, the span shall not exceed 45 times the actual thickness of the plank.

(*d*) *Exterior-wall framing.*—Studs shall not be spaced more than 24 inches on centers. Floor, roof, and ceiling beams shall be supported at the exterior walls upon posts which are adequate to support the load and whose dimensions are not less than 4- by 4-inch nominal size.

(*e*) *Interior columns.*—Where beams abut over a column, a column dimension of not less than 8 inches parallel to the direction of the beams shall be used to provide suitable bearing for the beams. Basement columns shall have a cross section of at least 6 by 6 inches; those in other stories shall be at least 4 by 4 inches, all dimensions being nominal.

(*f*) *Fastenings.*—All structural members shall be adequately nailed to each other at their junction to provide a well-integrated structure. Girders shall be fastened to each other where they intersect or abut, so as to resist safely a lateral force equal to the assumed wind pressure.

### 10. *Wood Houses With Plywood Coverings*

(*a*) *Material.*—The term "plywood" as used in this Code shall mean a built-up board or piece of wood made of three or more layers of veneer joined with glue and so laid that the grain of adjacent plies is at right angles. An odd number of plies shall be used.

Plywood to be exposed to the weather or to severe conditions of service shall meet the requirements established for "Exterior Class" in Commercial Standard CS45–40 for Douglas Fir Plywood. (See Appendix, par. 709–10 (a).)

Plywood for interior use above grade and not subjected to severe conditions of service shall meet the requirements established for the "Moisture Resistant Class" in Commercial Standard CS45–40 for Douglas Fir Plywood. (See Appendix par. 709–10 (a).)

(*b*) *Gluing plywood to framing members.*—Glue at least equal to casein or cold-press resin glue shall be used for gluing plywood to framing members of walls and ceilings used under normal conditions of service. The casein glue shall meet the requirements of Navy Department Specifications 52G8b (July 1, 1932) for water-resistant casein glue. Cold-setting resin glue shall meet the requirements of Navy Aeronautical Specification Glue; Cold-Setting Resin G–29 (4 April 1941). (See Appendix, par. 709–10 (b).)

Joints shall be of such quality that when tested to destruction in the dry condition, at least 50 percent of the failure shall be in the wood.

Similar glue joints may be used for floor units if adequate ventilation beneath the house is provided. (See sec. 709–11 (d).)

(*c*) *Design of flat panel with stressed coverings.*—Design of flat panel with stressed coverings shall conform to good engineering practice. (See Appendix, par. 709–10 (c).)

[15] Plank-and-beam structural floor or roof system consists of plank subfloor or roof decking with supporting beams spaced up to 7 feet apart, instead of the usual boards for subfloor or roof decking with joists or rafters spaced the customary 12 to 24 inches.

(*d*) *Fastenings.*—All structural members shall be so connected at their junction as to provide a well-integrated structure.

The fastenings of panel coverings to longitudinal members by any means less rigid than gluing (such as nailing) shall not be considered as providing a stressed covering.

### *11. Termites and Decay*

(*a*) *Site of building.*—Adequate drainage shall be provided at the building site.

(*b*) *Removal of debris.*—All wood debris shall be removed from the building site before construction is begun. No boards, stakes, or scraps of lumber shall be buried or left about the building.

(*c*) *Foundations.*—All foundations shall be made impervious to termites. If unit masonry is used it shall be capped with 4 inches of reinforced concrete or equivalent.[16]

(*d*) *Foundation wall vents.*—Adequate cross ventilation shall be provided beneath all wood construction over the ground so that no dead-air pockets exist.

For each area enclosed by exterior, fire, common-property-line, or party walls, the minimum net area of vent openings in the exterior walls shall be equal to one-half of 1 percent of the enclosed area plus one-half of 1 square foot for each 25 lineal feet of wall surrounding the area. When the building site is relatively wet at frequent periods, the area of openings thus obtained shall be doubled.

(*e*) *Porches.*—Porches, steps, and terraces shall be insulated from the foundation and woodwork so as to prevent termites and moisture from gaining access to the building from the fill or space beneath the entrance platform. (See Appendix, par. 709–11.)

(*f*) *Selection of lumber.*[17]—No lumber showing evidence of decay shall be used.

(*g*) *Closeness to ground.*—Except as permitted in Section 704–4 (a), no wood shall be placed in contact with the soil. Clearance under buildings without basements shall be a minimum of 18 inches below the bottom of all wood substructures, to allow crawl space for making inspections. Access doors or openings shall be provided.

All wood used in basements, such as stair carriages, door frames, partitions, or posts, shall rest on poured-concrete plinths, pedestals, or curbs that extend above the general floor level.

(*h*) *Girders in masonry or reinforced-concrete walls.*—Air spaces of ½ inch or more shall be provided around the ends of girders located below or near the grade line and which rest on masonry or reinforced concrete from which moisture may be absorbed, unless the girders are treated with an approved pressure preservative treatment or are made of all heartwood of one of the more decay-resistant species. (See Appendix, par. 709–11.)

(*i*) *Floor sleepers.*—Floor sleepers, furring strips, or other wood embedded in or laid on masonry or concrete that is in direct contact with the ground shall be treated with an approved pressure preservative treatment. Pieces shall be completely framed before treatment whenever possible; but when cutting after treatment is unavoidable, the cut surfaces shall be given two brush coats of a suitable preservative. (See sec. 704–4 (a).)

(*j*) *Protection of material.*—Every other material into the composition of which cellulose enters and which forms a part of a building shall be protected in a manner similar to that required for wood.

(*k*) *Expansion joints.*—Expansion joints in floors and space around pipes penetrating floors and walls shall be sealed with coal-tar pitch, coal-tar plastic cement, or crimped metal connectors.

(*l*) *Water pipes.*—Water pipes shall be suspended from the joists in basements to prevent the absorption of condensation water by the wood.

(*m*) *Flashing over doors and windows.*—Adequate flashings shall be used over doors and windows to provide ready drainage of water.

(*n*) *Moisture in walls.*—A vapor-resistant barrier shall be used at or near the inner face of the exterior walls to prevent the accumulation of moisture in the walls.

---

[16] Requirements concerning termites are intended only for those areas where it has been established that termite infestation exists. (See Appendix, par. 709–11.)

[17] Precautions should be taken to guard against excessive moisture content caused by conditions during delivery and installation.

## CHAPTER VIII. FIRE PROTECTION

### Section 800. General

When construction is required to have a definite fire resistance, this shall be determined under the procedure set forth in the Standard Specifications for Fire Tests of Building Construction and Materials, ASTM Designation C 19–41 of the American Society for Testing Materials. (See Appendix, par. 800.)

The provisions of this chapter are minimum requirements for fire-protection purposes and shall not be deemed to modify any other requirements of this Code, nor shall they be construed to modify any zoning requirements that may apply.

### Section 801. Fire Separation

#### *1. Between Dwellings*

If dwellings are not attached or do not adjoin, a clear space not less than 10 feet wide shall be left between them and a clear space not less than 5 feet wide shall be left between dwellings and common property lines. (See ch. III.)

#### *2. Between Dwelling Units*

Walls, floors, and other construction separating dwelling units shall have a fire resistance of at least ¾ hour. Such walls or partitions shall extend from the finished grade or from floor construction having a fire resistance of not less than ¾ hour when over a common basement or cellar. When the attic space is or can be used for storage, they shall extend up to the under side of the roof sheathing; provided that when attic space cannot be used for storage and there is an incombustible finish on the ceiling of the top story, the walls or partitions may terminate at the ceiling of such story. (See ch. III; sec. 402–2; and Appendix, par. 801.)

#### *3. Fire Walls*

Fire walls shall be ground supported, and self-supporting in the event of collapse of adjoining construction on one side. They shall extend to the inner face of wall and roof sheathing. In the case of roofs of masonry or reinforced concrete, fire walls shall be built up tightly to the under side of the roof.

#### *4. Chimneys*

No combustible beams, joists, or rafters shall be placed within 2 inches of the outside face of chimneys or of masonry enclosing a flue, provided that this distance may be reduced to ½ inch when the members are faced to their full depth with asbestos insulating board or other approved insulating material not less than ¼ inch thick. No combustible studding, lathing, furring, or plugging shall be placed against any chimney or in the joints thereof. Such combustible construction shall either be set away from the chimney or the plastering shall be directly on the masonry or on metal lath and furring or on other incombustible lathing and furring material. Combustible furring strips placed around chimneys to support base or other trim shall be insulated from the masonry by asbestos paper at least ⅛ inch thick, and metal wall plugs or approved incombustible nail-holding devices attached to the wall surface shall be used for nailing.

#### *5. Hazardous Spaces*

Except in single- and two-family dwellings, boiler rooms, incinerator rooms, storage rooms for inflammable materials, and coal bins shall be enclosed by incombustible construction having a fire resistance of at least ¾ hour. Openings into such enclosures, except coal bins, shall be protected by approved self-closing fire doors.

#### *6. Garages*

When a garage for not more than two automobiles is located within a single- or two-family dwelling, the walls, partitions, and ceiling shall be protected on the garage side with a fire-resistant construction at least equal to an incombustible facing not less than ½ inch thick or with such a facing not less than ⅜ inch thick backed with tongue-and-groove boards not less than 1 inch in nominal thickness.

When a garage for more than two and not more than five automobiles is located within a dwelling, the floor construction above the garage and the walls and partitions enclosing it shall have a fire resistance of at least ¾ hour.

When a garage for more than five automobiles is loeated within a dwelling, the floor construction above the garage and the walls and partitions enelosing it shall be fireproof.

When a garage is attaehed to a dwelling, the ceiling construetion over the garage and the walls separating it from the dwelling shall be of eonstruetion eonforming to that given above, aeeording to the number of automobiles aceommodated.

When a garage aeeommodates up to five automobiles, openings from a dwelling into the garage shall be restrieted to a single doorway provided with a door covered with metal on the garage side or a flush type wood door not less than 1¾ inehes in nominal thiekness. In the case of garages aeeommodating a larger number of automobiles, such openings shall be provided with approved self-closing fire doors. No glass shall be permitted in any door between a dwelling and a garage. Every door sill shall be raised at least 7½ inches above the garage floor level.

Garage floors shall be of incombustible material.

Heating devices for garages shall be installed in approved separate heating rooms or shall be of an approved type installed approximately at the eave level or near the eeiling.

### Seetion 802. Firestopping

#### *1. General*

Firestopping shall be supplied at the locations speeified in this seetion and shall be so arranged as to eut off all eoneealed draft openings and form an effeetual fire barrier between stories and between the upper story and the roof space. (See Appendix, par. 802–1.)

#### *2. Exterior Walls*

(*a*) *Wood construction.*—Exterior walls of wood eonstruction shall be properly firestopped at each floor level and at the level where the roof rafters eonneet with the wall plate.

(*b*) *Furred spaces.*—For all masonry walls that are furred or studded off, the spaee created by the furring or studding shall be properly firestopped once in eaeh story. Spaees around chimneys shall be firestopped with ineombustible material.

#### *3. Partitions*

Where stud partitions rest direetly over eaeh other and the studs run down between the floor beams and rest on the top plate of the partition below, the spaees between the studding shall be properly firestopped.

#### *4. Stairs*

The spaee between stair earriages shall be firestopped by a header beam at top and bottom. Where a stair run is not all in one room or where a eloset is located beneath the stairs, the stair carriages shall have an intermediate firestop, so loeated as to eut off communication between portions of the stairs in different rooms, or between the eloset and the room in which it is plaeed. Sueh stops shall be made of plank or other suitable material.

If a flight of stairs leading to the second story is over a flight of stairs leading to the basement or eellar, the stair eonstruetion to the seeond story shall have a fire resistance of at least 1 hour, provided that this shall not apply to stairways within dwelling units.

#### *5. Pipes or Ducts*

Where any pipe or duet passes through a floor, the spaee between the pipe or duct and the floor eonstruetion shall be firestopped.

Where the installation of pipes, ducts, or eonduits in walls, floors, or partitions requires the removal of any firestopping, the spaees around the pipes, ducts, or conduits at sueh points where firestopping was removed shall be tightly filled with asbestos, mineral wool, or other ineombustible insulating material.

#### *6. Sliding Doors*

When sliding doors are pocketed in partitions, sueh poekets shall be eompletely firestopped at the top, bottom, and ends.

#### *7. Exterior Cornices*

Exterior eornices built of wood or having wood frames on rows of buildings shall be either fully firestopped between each building or completely separated.

*8. Inspection*

No firestopping shall be concealed from view until opportunity has been given the building official to inspect the same.

Section 803. Shafts

*1. Enclosure Required*

Shafts passing through space occupied by more than one dwelling unit shall be enclosed with construction having a fire resistance of at least ¾ hour.

Shafts passing through more than one story of space occupied by one dwelling unit shall be lined with sheet metal or other approved incombustible material.

The bottoms of shafts not extending to the basement or cellar floor and the tops of shafts not extending through the roof shall be enclosed as required above.

*2. Openings*

Openings in shafts shall be restricted to those necessary for the purpose of the shaftway. Such openings shall be protected with approved fire doors or other approved protective devices in the case of shafts required to have a definite fire resistance and by doors or other devices lined with sheet metal or other approved incombustible material in the case of shafts required to be lined with metal or incombustible material.

*3. Connections*

The connections of shafts to adjoining construction having a lower fire resistance shall be such that the fire resistance of the enclosure will be maintained.

Section 804. Roof Coverings

Roof coverings shall conform to the following classifications, whose use is governed by the requirements of this Code for types of construction:[18]

*Class 1* roofing materials shall be effective against severe fire exposures, shall not carry or communicate fire, shall afford a relatively high degree of protection against fire to any combustible roof deck on which they may be placed, shall not slip from position, shall possess no flying-brand hazard, and shall not require frequent repairs to maintain their fire-protective properties.

*Class 2* roofing materials shall be effective against moderate fire exposures, and shall not be readily flammable or carry or communicate fire. They shall afford a moderate degree of protection to the roof deck, shall not slip from position, shall possess no flying-brand hazard, and shall require only infrequent repairs in order to maintain the above properties.

*Class 3* roof coverings shall not be readily flammable or carry or communicate fire under light fire exposures, shall afford some degree of protection to the roof deck, shall not slip from position nor possess any flying-brand hazards, and shall maintain these properties with only occasional repairs.

*Class 4* roof coverings present less resistance to ignition from sources such as flying brands than the Class 3 coverings and give at least a slight degree of protection to the roof deck. In burning they will give off flying brands. Their susceptibility to ignition from brands on the roof will increase with time. As applied by accepted methods, they will not slip from position.

*Class 5* comprises wood shingles that on account of thickness, length, treatment, coatings, underlay, or supporting sheathing are not included in Class 3 or 4. It does not include very readily ignitable and hazardous roofing materials such as light asphalt or tar-impregnated paper and straw thatch.

## CHAPTER IX. CHIMNEYS AND HEATING APPLIANCES

Section 900. General

Chimneys and heating appliances shall be constructed and installed in accordance with good practice, provided that the specific requirements in this chapter shall be observed. (See Appendix, par. 900.)

Section 901. Construction of Chimneys

*1. Materials*

Chimneys shall be of approved masonry or reinforced concrete or of other approved materials.

[18] For specific materials that will meet these requirements, see Appendix, par. 804.

*2. Foundations*

Masonry or reinforced-concrete chimneys shall not rest upon or be carried by wood floors, beams, or brackets, nor be hung or supported by metal stirrups from wood construction, but shall be built upon concrete or masonry foundations or reinforced-concrete slabs properly proportioned to carry the load without danger of settlement or cracking. The footings shall be carried below the frost level.

*3. Bonding*

Masonry or reinforced-concrete walls of buildings may form parts of chimneys when the chimney walls are securely bonded into the walls of the building and when the flue is lined with flue lining the same as an independent chimney.

*4. Corbeling of Chimneys*

Corbeled chimneys shall not be supported by hollow walls, cavity walls, or walls of hollow units. Solid walls supporting corbeled chimneys shall be not less than 12 inches thick, and corbeling shall not project more than 1 inch per course and not more than 6 inches in any case.

The total offset, overhang, or corbel of an independent chimney shall not exceed ⅜ the width of the chimney in the direction of the offset.

*5. Height*

Chimneys shall be built at least 2 feet above flat roofs, provided that the tops of chimneys shall not be below the tops of adjacent parapet walls. In the case of sloping roofs, chimneys shall be not less than 1 foot above the ridge of the roof that the chimney penetrates and not less than 1 foot above the highest ridge within 10 feet of the chimney. Unless provided with a stone, terra-cotta, concrete, cast-iron, or other special cap or top, the chimney lining shall project not less than 2 inches. No chimney top shall decrease the required flue area.

*6. Concrete Chimneys*

Concrete for chimneys cast in place shall flow readily, be well rodded, and shall be reinforced vertically and horizontally. The walls shall be at least 3¾ inches thick and shall be lined throughout with fire-clay flue lining.

*7. Hollow Masonry Units*[19]

Hollow masonry units shall not be used for the walls of an independent chimney, but may be used for chimneys built in connection with exterior walls of buildings built of hollow units, in which case the chimney walls shall be at least 8 inches thick. The outer 8 inches of a building wall may serve as the outside wall of the chimney, but the remaining chimney walls shall be constructed of two layers of 4-inch hollow units set with broken vertical joints, or they may be built of 4 inches of solid masonry. In either case, the outside wall of the chimney shall be securely bonded into the walls of the building. No chimney shall be corbeled from a wall built of hollow units.

*8. Solid Concrete Block*

Solid concrete block used in chimney construction shall be at least 3¾ inches thick, and blocks enclosing more than one flue shall have suitable reinforcement completely encircling the blocks and well embedded in them.

*9. Stone*

The walls of chimneys built of sawed or dressed stone in courses, properly bonded at corners and tied with metal anchors, shall be at least 3¾ inches thick. Chimney walls of other stone shall be at least 8 inches thick.

*10. Flashing*

Connections between chimneys and roofs shall be made with cap and base flashing of sheet metal or other approved material, arranged to allow for any lateral or vertical movement between chimney and roof.

*11. Change of Interior Dimensions*

No change in the interior dimensions of chimneys shall be made within a distance of 6 inches above or below the rafters or roof joists.

[19] Tests now in progress may disclose the advisability of relaxing these requirements.

*12. Special Types of Chimneys*

Chimneys of construction other than covered in the foregoing requirements shall be permitted only when approved by the building official and installed in accordance with regulations issued by him. (See Appendix, par. 901–12.)

Section 902. Flues

*1. Flue Lining*

Chimneys built of brick, stone, or other masonry units shall be lined throughout with fire-clay flue lining; provided that in chimneys having solid brick walls 8 inches or more thick, the flue lining may be omitted. Flue linings shall be at least ⅝ inch thick, and shall be suitable for the purpose and adapted to withstand high temperatures and the resultant gases from burning fuel. The flue sections shall be set in Type A or Type B mortar. The joints shall be smooth on the inside.

*2. Separation*

When two or more flues are contained in the same chimney, withes of brick or mortar not less than 3¾ inches thick shall be provided at intervals not exceeding 30 inches horizontally, but not more than two flues without such separation. Where the flue linings are not separated by withes, the joints shall be staggered and the vertical distance between joints in adjoining flue linings shall be not less than 7 inches.

*3. Construction*

The masonry shall be built around each section of lining as it is placed, and all spaces between masonry and linings shall be filled with mortar. Linings shall start at least 8 inches below the center line of smoke-pipe intakes or, in the case of fireplaces, from the apex of the smoke chamber and shall be continuous the entire height of the flue. No smoke-pipe intake shall be cut into a flue lining already set in place. Flues shall be built as nearly vertical as possible, but in no case at an angle greater than 45 degrees from the vertical. Where flues change direction, the abutting linings at the angle joints shall be cut to fit closely, and at no point shall the cross-sectional area be reduced.

*4. Area*

The inside effective area of flue linings shall be not less than the area of the smoke outlets on the appliances to which the flue is connected, but not less than 1/12 the opening for fireplaces. The least dimension of any rectangular flue shall be not less than ½ of the greatest dimension.

For flues serving several gas appliances, the flue area shall be at least equal to the aggregate areas of the appliance outlets.

Single vent flues for storage water heaters, stoves, ranges, and other domestic gas appliances having relatively small gas consumption shall have a flue diameter of at least 3 inches, provided, however, that this shall not apply to gas plates and portable gas heating appliances. Such flues, unless enclosed in solid masonry walls, shall be of incombustible material of approved design and thickness, and shall vent through and above the roof.

The diameter of a vent flue serving a gas-fired instantaneous or continuous-flow water heater shall be not smaller than the diameter of the outlet on the appliance to which it is connected.

*5. Cleaning*

Flues shall be thoroughly cleaned and left smooth on the inside.

Section 903. Fireplaces

*1. Use of Firebrick*

The walls of fireplaces shall be not less than 8 inches thick, provided that if built of stone or hollow units they shall be not less than 12 inches thick. The faces of such minimum-thickness walls exposed to fire shall be lined with firebrick, soapstone, cast iron, or other suitable fire-resistive material. When lined with at least 4 inches of firebrick, such lining may be included in the required minimum thickness. When the firebrick lining is less than 4 inches thick, such lining shall not be included in the required thickness.

*2. Incombustible Hearths*

Fireplaces, except when designed and used for approved gas appliances only, shall have hearths of brick, stone, tile, or other approved

incombustible material supported on masonry or reinforced concrete. Such hearths shall extend at least 16 inches outside the chimney breast and not less than 8 inches each side of the fireplace opening along the chimney breast. The arches shall be of brick, stone, hollow tile, or other approved masonry at least 4 inches thick. A flat stone or a reinforced-concrete slab may be used to carry the hearth instead of an arch, if it is properly supported and a suitable fill is provided between it and the hearth. Hearths shall be of brick, stone, tile, or concrete, as may be specified. The combined thickness of the hearth and supporting arch or slab shall be not less than 6 inches at any point.

*3. Fire Prevention*

(*a*) *Removal of wood centering.*—Wood centering used in the construction of any part of the supporting arch of a fireplace, which is below the hearth and inside the chimney breast, shall be removed when the construction of the arch is completed and before plastering on the underside.

(*b*) *Clearances from combustible construction.*—No combustible construction shall be placed within 4 inches of the back wall of any fireplace. Combustible or unprotected header beams supporting trimmer arches at fireplaces shall be not less than 20 inches from the face of the chimney breast.

No combustible mantel or other combustible construction or finish shall be placed within 8 inches of either side or of the top of any fireplace opening, provided that no combustible mantel shelf shall be less than 12 inches above such opening.

Section 904. Smoke Pipes

*1. Connection With Flue*

(*a*) *Connection required.*—Every smoke pipe shall connect with a smoke flue by means of a tight joint.

(*b*) *Number limited.*—Not more than one smoke pipe shall be connected to a flue. A vent from a gas-burning appliance not exceeding 13 square inches may connect into the same flue as a smoke pipe provided the connection is above the smoke pipe.

(*c*) *Thimbles.*—Thimbles shall be built in at the time the chimney is built. Smoke pipes shall enter chimneys through a fire-clay or metal thimble or flue ring of masonry. Neither the intake pipe nor the thimble shall project into the flue.

*2. Passage Through Combustible Construction*

(*a*) *Ceilings, floors, roofs.*—No smoke pipe shall pass through a ceiling, floor, or roof construction of combustible material.

(*b*) *Partitions.*—Smoke pipes shall not pass through combustible partitions, unless protected by double metal ventilated thimbles 8 inches larger in diameter than the pipe or 4 inches larger in diameter than the pipe, with the space between the pipe and the thimble filled solidly with approved incombustible insulating material, or unless protected by a concentric sleeve of diameter 2 inches larger than the pipe, with the space between filled solidly with incombustible insulating material and the outside surface of the sleeve distant at least 2 inches from combustible material.

*3. Clearances From Combustible Construction*[20]

The clear distance in all directions between a smoke pipe and combustible construction, including plaster on a combustible base, shall be not less than 12 inches; provided that this clearance may be reduced one-half when such construction is protected by cement-asbestos board or asbestos millboard not less than ¼ inch thick or equivalent approved covering extending the full length of the smoke pipe and not less than 12 inches beyond it on both sides, or where plaster is on metal or wire lath.

Section 905. Mounting of Heat Appliances

*1. General*

Except as hereinafter otherwise provided, heat appliances shall be mounted on masonry bases not less than 3 inches thick supported on the ground, or they shall be mounted on floors of fireproof construction with incombustible flooring or surface finish, or on trimmer arches supporting hearths as required in this Code for fireplaces, in all cases extending not less than 12

[20] These clearances may be decreased when it has been established by test that lesser distances are safe for a particular installation.

inches beyond such appliances on all sides or to the partitions of the room in which the heater is located.

*2. Hearths*

Stoves or ranges burning solid fuel, the lower surface of which is a portion of the fire box, shall be set on hearths supported by masonry trimmer arches extending not less than 6 inches on all sides beyond such appliances; provided that when such appliances have legs giving an open air space of not less than 5 inches below the bottom of the appliance, they may be set on sheet metal underlaid with not less than ¼ inch of asbestos or other equivalent approved incombustible material; and, provided further, that where such appliances have ash boxes under the entire fire box and are set on legs giving an open air space of not less than 5 inches below the bottom of the appliance, they may be set on sheet metal.

*3. Clearances for Stoves and Ranges*[21]

No stove or range shall be placed within 24 inches from combustible construction nor within 18 inches of combustible supports or combustible base of plastered construction; provided that when such construction is protected by a shield of galvanized or bright sheet metal or other equivalent approved incombustible material extending from the floor to 1 foot above and 1 foot beyond the sides of such appliances, these distances may be reduced one-half.

*4. Clearances for Gas Ranges*

Domestic gas ranges shall have a distance between the burners and a combustible floor of not less than 12 inches unless such floors are protected with asbestos board under sheet metal or other equivalent approved incombustible material. The oven back or side of the cooking top shall be not less than 6 inches from combustible material unless such material is protected by approved incombustible material as in the case of burners.

[21] These clearances may be decreased when it has been established by test that lesser distances are safe for a particular stove or range and such clearances are recommended by the manufacturer.

*5. Bases for Heating Furnaces*

Unless otherwise approved by the building official, hot-air, hot-water, and steam heating furnaces installed on wood-joisted floors or on other combustible construction shall have protective bases of sheet metal or asbestos-cement board. In addition to and above this base, there shall be a hollow masonry base arranged for free air circulation through it for all coal-fired equipment and for all other equipment not protected by a wet base or which does not have a combustion chamber at least 12 inches above the floor.

*6. Clearances for Heating Furnaces*[22]

No hot-air, hot-water, or steam heating furnace shall be located nearer than 24 inches in any direction to woodwork or other combustible material or construction, including plaster on combustible base. In the case of furnaces which are enclosed in jackets providing an air space or which are insulated in an approved manner, this distance may be reduced to 18 inches; provided that when combustible material is protected with ⅜-inch gypsum board under ⅛-inch asbestos board, or with ¾-inch portland cement plaster on metal lath, this distance may be further reduced to not less than 6 inches.

Section 906. Ducts

*1. Material*

Warm-air ducts, fittings, and connections in warm-air heating systems shall be made of bright tin, galvanized iron, or other approved incombustible material.

*2. Protection*

(*a*) *Clearances from combustible construction.*— The clear distance between exposed warm-air ducts leading from the furnace to vertical or wall stacks and combustible construction shall be not less than 1 inch unless such construction is covered with asbestos paper weighing not less than 12 pounds per 100 square feet and the paper covered with galvanized or bright

[22] These clearances may be decreased when it has been established by test that lesser distances are safe for a particular type of heater and such clearances are recommended by the manufacturer.

sheet metal, or unless equivalent protection is provided.

(*b*) *Clearances within floors and partitions.*—If the bonnet temperature of a warm-air heating system exceeds 200° Fahrenheit, no warm-air duct shall enter a floor, partition, or other construction of combustible material unless it is at least 6 feet distant in a horizontal direction from the furnace or unless it is covered with asbestos paper or millboard at least ⅛ inch thick or equivalent approved protection. A clearance of not less than 5/16 inch shall be maintained between combustible construction and warm-air heating stacks, floor or wall ducts, and their inlets and outlets, and they shall be covered with not less than one thickness of asbestos paper weighing not less than 12 pounds per 100 square feet, or equivalent approved protection.

### *3. Cold-Air Ducts*

The cold-air ducts of heating systems within 6 feet of their connection with the furnace shall be of metal or approved incombustible material.

## Section 907. Registers

### *1. Setting*

If the bonnet temperature of a warm-air heating system exceeds 200° Fahrenheit, registers used in heating systems, placed in woodwork or in combustible floors, shall be surrounded with a border of incombustible material not less than 2 inches wide, securely set in place, or shall be installed in some other approved manner.

### *2. Register Boxes*

If the bonnet temperature exceeds 200° Fahrenheit, floor registers shall be provided with double register boxes of tin or galvanized iron or other approved incombustible material, with an air space of not less than 5/16 inch between inner and outer boxes; or, where single boxes are used, they shall be insulated from the wood or other combustible material by asbestos paper weighing not less than 12 pounds per 100 square feet and a clear space of not less than 5/16 inch shall be left from combustible material.

### *3. One-Pipe Furnaces and Floor Furnaces*

When a register box is placed in a combustible floor directly over a one-pipe furnace or floor furnace, the register box shall be constructed double with a vented air space of not less than 4 inches between, except where the warm-air passage is surrounded by a cold-air passage.

Combustible material enclosing register boxes of wall-register type furnaces shall be insulated from the register box with an incombustible material having a maximum coefficient of heat transmission of 1.0 Btu per square foot per hour per degree of temperature difference for the thickness used.

With the exception of wall-register types of furnaces, floor furnaces shall not be placed closer than 6 inches to the nearest wall. Wall-register types shall not be placed closer than 6 inches to a corner.

Furnaces shall be so placed that a door, drape, or similar object cannot be directly over or less than 12 inches in front of the register of the furnace.

### *4. Fixed Registers*

If the bonnet temperature of a warm-air heating system exceeds 200° Fahrenheit, one register without valve or movable louvers shall be provided in the system.

## Section 908. Mechanical Circulation Warm-Air Systems

### *1. General*

Except as may be otherwise provided in law, in this section, or in duly promulgated regulations, the Standards of the National Board of Fire Underwriters for the Installation of Air Conditioning, Warm Air Heating, Air Cooling and Ventilating Systems or the recommendations of the National Warm Air Heating and Air Conditioning Association shall be deemed to be generally accepted good practice in the design and installation of mechanical circulation warm-air systems. (See Appendix, par. 908.)

### *2. Recirculation*

The installation of equipment providing the recirculation of air from one dwelling unit to another is forbidden.

*3. Return Ducts*

No return duct of a mechanical circulation warm-air system shall be permitted from a kitchen, bathroom, or garage.

Section 909. Steam and Hot-Water Pipes

*1. Clearances From Combustible Construction*

Where steam or hot-water pipes pass through combustible floors or partitions, or other combustible construction, there shall be on all sides of the pipe an open space which shall be enclosed at the ends with incombustible material.

*2. Pipe Coverings*

Coverings or insulation used on steam or hot-water pipes shall be of incombustible material.

Section 910. Appliances

*1. Gas Appliances*

(*a*) *General.*—Except as may be otherwise provided in law, in this section, or in duly promulgated regulations, the Approval Requirements for Central Heating Gas Appliances and the Requirements and Recommended Practice for House Piping and Appliance Installation of the American Gas Association shall be deemed to be generally accepted good practice with respect to such appliances. (See Appendix, par. 910.)

(*b*) *Gas logs.*—No gas log, gas grate, or similar heating appliance shall hereafter be installed except in a fireplace constructed as prescribed by this Code and connected with a smoke flue or an outlet pipe as hereinafter provided.

(*c*) *Gas-fired furnaces.*—Gas-fired steam or hot-water furnaces shall be installed as prescribed in this Code for heat appliances and shall be connected with a smoke flue conforming to this Code.

(*d*) *Water heaters.*—Water heaters shall be connected to smoke flues or outlet pipes as hereinafter provided.

(*e*) *Venting.*—Outlet pipes for venting gas appliances shall be standard cast-iron soil pipe, terra-cotta pipe, or other approved incombustible material, so connected as to prevent leakage at the joints.

Such outlet pipes shall have cross-sectional areas of not less than the aggregate areas of the vent outlets of the appliances connected to them.

Such outlet pipes shall be connected to chimneys or be carried to and through the roof or through an exterior wall to the outer air. When not connected to chimneys, they shall be surmounted by a suitable cap.

Unless insulated with not less than one thickness of asbestos paper weighing not less than 12 pounds per 100 square feet, or with equivalent protection, such outlet pipes shall be separated from woodwork or other combustible material by a clearance on all sides of not less than 1 inch.

(*f*) *Liquefied petroleum gases.*—Except as may be otherwise provided in law, in this section, or in duly promulgated regulations, the Standards of the National Board of Fire Underwriters for Liquefied Petroleum Gases as recommended by the National Fire Protection Association shall be deemed to be generally accepted good practice with respect to the use of such gases. (See Appendix, par. 910.)

*2. Oil-Fired Appliances*

Except as may be otherwise provided in law, in this section, or in duly promulgated regulations, the Commercial Standard for Automatic Mechanical Draft Oil Burners Designed for Domestic Installations, CS75–39, promulgated by the United States Department of Commerce through the National Bureau of Standards, and the Standards of the National Board of Fire Underwriters for the Installation of Oil Burning Equipment shall be deemed to be generally accepted good practice with respect to such appliances. (See Appendix, par. 910.)

Natural-draft oil burners shall be installed in accordance with generally accepted good practice.

*3. Steam and Hot-Water Boilers*

Except as may be otherwise provided in law, in this section, or in duly promulgated regulations, steam and hot-water heating boilers shall conform to the Code for Low Pressure Heating Boilers of the American Society of Mechanical Engineers. (See Appendix, par. 910.)

*4. Automatic Stokers*

Except as may be otherwise provided in law, in this section, or in duly promulgated regulations, the Commercial Standard for Domestic Burners for Pennsylvania Anthracite, CS48–40, promulgated by the United States Department of Commerce through the National Bureau of Standards shall be deemed to be generally accepted good practice with respect to the installation of automatic stokers using anthracite. The installation of other types of automatic stokers shall be in accordance with generally accepted good practice. (See Appendix, par. 910.)

### Section 911. Combustion

Adequate facilities shall be provided for the entrance of air to support combustion in rooms or other spaces enclosing heat appliances, provided that the area of such facilities shall be not less than the outlet area of the appliances.

## CHAPTER X. SAFEGUARDS AGAINST ACCIDENTS [23]

### Section 1001. Stairways

All interior stairways, including basement stairways, shall have handrails on at least one side. When 44 inches or more in width they shall have handrails on both sides.

All stairways shall have a minimum headroom of 6 feet 8 inches measured from stairway treads to construction above.

### Section 1002. Steps

Outside steps attached to a dwelling and containing more than three risers shall have at least one handrail, provided that this may be omitted in the case of bulkhead stairs leading to a basement.

### Section 1003. Porches and Terraces

Porches and terraces attached to a dwelling and with their floors more than 18 inches above finished grade shall be provided with adequate railings.

The least dimension of porches and terraces shall be 3 feet 6 inches.

[23] See Appendix, par. 1000.

## CHAPTER XI. ELECTRICAL

### Section 1100. General

Electric wiring and electric equipment for light, heat, or power shall conform to generally accepted good practice.

### Section 1101. National Electrical Code

Except as may be otherwise provided in law, in this chapter, or in duly promulgated regulations, the National Electrical Code, as approved by the American Standards Association, shall be deemed to be generally accepted good practice. (See Appendix, par. 1101.)

### Section 1102. Inspection [24]

No electric wiring shall be covered or concealed until it has been inspected and permission to conceal has been given by the building official.

## CHAPTER XII. PLUMBING

### Section 1200. General

Plumbing shall conform to generally accepted good practice.

### Section 1201. Plumbing Standards

Except as may be otherwise provided in law, in this chapter, or in duly promulgated regulations, the provisions contained in the report entitled "Emergency Plumbing Standards for Defense Housing," issued by the Division of Defense Housing Coordination, shall be deemed to be generally accepted good practice. (See Appendix, par. 1201.)

### Section 1202. Sanitary Fixtures

In every dwelling unit in a multiple dwelling and in every other dwelling unit to which running water and sewerage are available, there shall be provided not less than one water closet, one bathtub or shower, one lavatory, and one kitchen sink. (See Appendix, par. 1202.)

[24] This section applies in localities where electrical inspection is under the jurisdiction of the building official. Where the official is unfamiliar with electrical work, it may be possible to arrange with the electrical inspector of a nearby city to make inspection. Otherwise, it may be possible to have an inspector sent by the state fire marshal or to accept a report of the representative of the local board of fire underwriters.

# APPENDIX

The information contained in this Appendix is presented to assist in interpreting and enforcing the Code requirements. It consists chiefly of references to useful source material and of detailed acceptable methods for meeting some of the more general requirements of the Code. Certain desirable building practices that may be necessary as requirements in certain localities because of special conditions are also mentioned.

The system of numbering employed in the Appendix corresponds with that in the Code, the term "Paragraph" being used instead of "Section" as in the Code itself. Thus, Paragraph 502 of the Appendix deals with some aspect of Section 502 in the Code. Since it is not necessary to have Appendix matter for every section in the Code, gaps will be found in the numbering of paragraphs in the Appendix.

### Paragraph 100. General

The address of the American Standards Association, mentioned in the note on page 7, is 29 West 39th Street, New York, N. Y.

### Paragraph 101. Temporary Permits

In general, the requirements of this Code are the minima judged necessary for safety and health and they apply to structures that are permanent in nature. It is recognized that in times of great emergency, extraordinary measures may be necessary in some places to provide adequate housing accommodations of a temporary nature. To provide for such contingencies, a system of temporary permits is suggested. One of the objections to permitting so-called "temporary" structures is the difficulty of getting rid of them after the emergency is over. The Code provides for demolition or removal when this time comes.

### Paragraph 102. Materials and Methods not Specifically Authorized

Much emphasis is placed today on so wording building code requirements that new materials and methods of construction can be utilized without undue delay. The committee has considered this problem and has come to the conclusion that, for the present at least, the matter is best handled in a general way. As time goes on and performance standards become more definite, it may be possible to carry more specific provisions.

### Paragraph 104. Private Water and Sewage-Disposal Systems

The matter of assuring adequate water supply and sewage disposal, although not customarily dealt with in building codes, is believed to be of major importance.

The publication referred to is a mimeographed document dated May 1941 and bears the title: Sanitation Code for Local Adoption. It is obtainable on application to the United States Public Health Service, Washington, D. C. A revised edition of this document is in preparation.

### Paragraph 300. Fire-Resistance Classifications

The classification of buildings given in Chapter III is based upon recommendations made by the Subcommittee on Fire Resistance Classifications of the Central Housing Committee on Research, Design, and Construction, in a report entitled "Fire Resistance Classifications of Building Constructions," obtainable from the National Bureau of Standards, Washington, D. C. Supplementary provisions which round out the requirements in this chapter are to be found in Chapter VIII, Fire Protection.

In general, the fire resistance required for walls and other structural members is made more specific than in many existing building codes and is somewhat reduced from that customarily required, particularly for fireproof buildings. The Subcommittee on Fire Resistance Classifications made its recommendations after a very careful survey of combustible contents in residential buildings. The requirements are intended to establish a more logical relationship between fire resistance provisions and combustible contents than has prevailed in the past.

### Paragraph 502. Windows

The requirements for glass area in Section 502–2 are based on average conditions and may well be modified according to latitude. For a discussion of the effect of latitude and of other considerations affecting natural lighting, see Principle 4, of Basic Principles of Healthful Housing, Second Edition, May 1939. Matters affecting ventilation are also discussed in this publication. It is a report of the Committee on the Hygiene of Housing of the American Public Health Association, 1790 Broadway, New York, N. Y., and is obtainable from the association for 25 cents.

### Paragraph 502–2. Glass Area

It is recommended that consideration be given to adding the following to the second paragraph of Section 502–2: "provided that in dwelling units where habitable rooms do not have cross or through ventilation, the aggregate glass area of windows, except in kitchens, shall be not less than 1/8 of the floor area;".

### Paragraph 502–4. Screening

Every dwelling which is located in an area in which flies or mosquitoes have not been effectively controlled should have all windows, ventilating openings, and doors to the outside equipped with screens of not less than 16 meshes to the inch. All outside screen doors should open outward and be self-closing.

### Paragraph 606–3. Lighting and Ventilation

One method of meeting the general requirement for artificial lighting in Section 606–3 would be to provide an electric-light outlet, centrally located, in every 150 square feet of hall area. In the case of natural light,

different floor plans require different arrangements of windows in order to provide reasonably uniform distribution of light. Consideration should be given to locating windows so that such a distribution will be afforded, particularly in short sections of hallway leading off from the main hallway.

### Paragraph 700. Quality of Materials

Standards and specifications mentioned in Section 700–1 may be obtained from the following sources:

Specifications of the American Society for Testing Materials—American Society for Testing Materials, 260 South Broad Street, Philadelphia, Pa.

Federal Specifications—Superintendent of Documents, Washington, D. C.

Standards of the American Standards Association—American Standards Association, 29 West 39th Street, New York, N. Y.

Commercial Standards—Superintendent of Documents, Washington, D. C.

### Paragraph 704. Foundations

The address of the American Wood Preservers' Association, mentioned in Sections 704–4 and 704–5, is 111 West Washington Street, Chicago, Ill.

### Paragraph 704–4. Design of Footings

The standards of the Federal Housing Administration, Washington, D. C., contain specific dimensions in harmony with this requirement.

### Paragraph 705. Masonry

The specifications referred to in Section 705–1 are obtainable from the American Society for Testing Materials, 260 South Broad Street, Philadelphia, Pa., for 25 cents each.

### Paragraph 705–1. Quality of Materials

Attention is called to the fact that under the general requirements of the Code, for quality of materials, the quality of lime used in lime mortar should conform to existing ASTM or Federal specifications.

### Paragraph 705–15(c). Lintels and Arches

In order to meet the requirements of Section 705–15 (c) for masonry arches, arches built of ordinary masonry units should have a rise of at least 1 inch for each foot of span. For flat arches, masonry units must be specially formed or ground.

### Paragraph 706. Reinforced Concrete

The building regulations mentioned in Section 706–1 are obtainable from the American Concrete Institute, 7400 Second Boulevard, Detroit, Mich., for 50 cents.

### Paragraph 707. Reinforced Brick Masonry

Principles of Brick Engineering, mentioned in Section 707, may be obtained from Structural Clay Products Institute, 1756 K Street, N.W., Washington, D. C., for $4.

### Paragraph 708. Steel and Iron

The specification mentioned in Section 708–1 is obtainable from the American Institute of Steel Construction, 101 Park Avenue, New York, N. Y.

Information about the use of light steel construction (see sec. 708–3) is obtainable from the American Iron and Steel Institute, 350 Fifth Avenue, New York, N. Y.

The specifications mentioned in Section 708–4 are obtainable from the Steel Joist Institute, 201 North Wells Street, Chicago, Ill.

When field welding of steel joists is permitted (see sec. 708–4), it is recommended that work conform to the requirements of Specification for Structural Steel Welding, No. 22Yb, October 1939, published by the Bureau of Yards and Docks, Navy Department, and obtainable from the Superintendent of Documents, Washington, D. C.

### Paragraph 709–1. General

The Wood Handbook of the United States Department of Agriculture is obtainable from the Superintendent of Documents, Washington, D. C., for 35 cents. In it will be found discussion of various matters affecting design, including stresses due to wind loads, impact stresses, shear, compression perpendicular to grain and on surfaces inclined to grain, and methods of determining allowable working stresses for short, intermediate, and long columns.

Adequate methods of nailing are described in the Wood Handbook and in the following:

Nail-Holding Power of American Woods, Technical Note No. 236, July 1931;

General Observations on the Nailing of Wood, Technical Note No. 243, August 1940;

Nailing Dense Hardwoods, Technical Note No. 247, April 1941;

Timber Fastenings, Separate Reprint from Wood Handbook.

These four items are obtainable without charge from Forest Products Laboratory, Madison, Wis.

In some cases it may be advantageous to make use of special timber connectors. These are described in the Wood Handbook.

### Paragraph 709–2. Determination of Required Sizes

Information on American Lumber Standards is to be found in the Wood Handbook of the United States Department of Agriculture, and in Simplified Practice Recommendation R16–39, Lumber: American Lumber Standards for Softwood Lumber, both obtainable from the Superintendent of Documents, Washington, D. C., for 35 and 20 cents, respectively.

Miscellaneous Publication 185, mentioned in Section 709–3, is obtainable from the Superintendent of Documents, Washington, D. C., for 5 cents, and the Supplement thereto, mentioned in the same section, is obtainable without charge from the Forest Products Laboratory, Madison, Wis.

For convenience in meeting the requirements of Section 709–3, tables of basic stresses, working stresses, and maximum spans of joists and rafters are presented here. The tables of working stresses take into account differences in species, grades, effect of knots, and other factors. Use of the tables of spans for joists and rafters will assure compliance with the provisions of Section 709–3.

In the case of roofs, tables 8 and 8a apply to pitches at or below 3 in 12, and spans determined by bending are for roof pitches of roofs which do not support plastered ceilings; tables 9 and 9a are for roofs of similar pitch supporting plastered ceilings. Tables 10 and 10a apply to roof pitches between the maximum indicated thereon and a minimum pitch of 3 in 12. They are for roofs having light roofing materials. Tables 11 and 11a apply to roof pitches of 8½ in 12 and greater and of 10½ in 12 and greater, and are for roofs having light roofing materials. Tables 12 and 12a apply to roof pitches between the maximum indicated thereon and a minimum pitch of 3 in 12 and are for roofs having heavy roofing materials. Tables 13 and 13a apply to roof pitches of 8½ in 12 and greater and of 10½ in 12 and greater, and are for roofs having heavy roofing materials.

Table 1.—*Basic stresses for clear material* [1]

[For material that is continuously dry or continuously wet]

| Species | Extreme fiber in bending | Compression perpendicular to grain [2] | Compression parallel to grain (l/d=11 or less) | Maximum horizontal shear | Modulus of elasticity |
|---|---|---|---|---|---|
| | *lb/in.*² | *lb/in.*² | *lb/in.*² | *lb/in.*² | *lb/in.*² |
| Ash, black | 1,333 | 300 | 866 | 120 | 1,100,000 |
| Ash, commercial white | 1,866 | 500 | 1,466 | 167 | 1,500,000 |
| Baldcypress | 1,733 | 300 | 1,466 | 133 | 1,200,000 |
| Beech, American | 2,000 | 500 | 1,600 | 167 | 1,600,000 |
| Birch, sweet and yellow | 2,000 | 500 | 1,600 | 167 | 1,600,000 |
| Chestnut, American | 1,266 | 300 | 1,066 | 120 | 1,000,000 |
| Douglas-fir, coast region | 2,000 | 325 | 1,466 | 120 | 1,600,000 |
| Douglas-fir, coast region, close-grained | 2,133 | 345 | 1,565 | 120 | 1,600,000 |
| Douglas-fir, Rocky Mountain region | 1,466 | 275 | 1,066 | 113 | 1,200,000 |
| Douglas-fir, dense, all regions | 2,333 | 380 | 1,711 | 140 | 1,600,000 |
| Elm, American and slippery [3] | 1,466 | 250 | 1,066 | 133 | 1,200,000 |
| Elm, rock | 2,000 | 500 | 1,600 | 167 | 1,300,000 |
| Fir, balsam | 1,200 | 150 | 933 | 93 | 1,000,000 |
| Fir, commercial white | 1,466 | 300 | 933 | 93 | 1,100,000 |
| Hemlock, eastern | 1,466 | 300 | 933 | 93 | 1,100,000 |
| Hemlock, western [4] | 1,733 | 300 | 1,200 | 100 | 1,400,000 |
| Hickory, true and pecan | 2,533 | 600 | 2,000 | 187 | 1,800,000 |
| Larch, western | [5] 1,600 | 325 | 1,466 | 133 | 1,300,000 |
| Maple, sugar and black [6] | 2,000 | 500 | 1,600 | 167 | 1,600,000 |
| Oak, commercial red and white | 1,866 | 500 | 1,333 | 167 | 1,500,000 |
| Pine, western white,[7] eastern white, ponderosa, and sugar | 1,200 | 250 | 1,000 | 113 | 1,000,000 |
| Pine, red | 1,466 | 300 | 1,066 | 113 | 1,200,000 |
| Pine, southern yellow [8] | 2,000 | 325 | 1,466 | 146 | 1,600,000 |
| Pine, southern yellow, dense | 2,333 | 380 | 1,711 | 171 | 1,600,000 |
| Redcedar, western | 1,200 | 200 | 933 | 106 | 1,000,000 |
| Redwood | 1,600 | 250 | 1,333 | 93 | 1,200,000 |
| Redwood, close-grained | 1,707 | 267 | 1,422 | 93 | 1,200,000 |
| Spruce, Engelmann | 1,000 | 175 | 800 | 93 | 800,000 |
| Spruce, red, white, and Sitka | 1,466 | 250 | 1,066 | 113 | 1,200,000 |
| Sweetgum | 1,466 | 300 | 1,066 | 133 | 1,200,000 |
| Tamarack | 1,600 | 300 | 1,333 | 126 | 1,300,000 |
| Tupelo | 1,466 | 300 | 1,066 | 133 | 1,200,000 |
| White-cedar, northern and Atlantic | 1,000 | 175 | 733 | 93 | 800,000 |
| White-cedar, Port Orford | 1,466 | 250 | 1,200 | 120 | 1,500,000 |
| Yellow-cedar, Alaska | 1,466 | 250 | 1,066 | 120 | 1,200,000 |

[1] Basic stresses are for determining design or working stresses according to the grade of timber and conditions of exposure.
[2] For material that is continuously wet take 70% of these values.
[3] Sold as white elm or soft elm.
[4] Also sold as west-coast hemlock.
[5] In setting up basic working stresses, consideration has been given to results of tests on small clear specimens and to tests on full-sized timbers of the species when the latter are available. That the value for stress in extreme fiber of western larch ought to be higher than that listed here is indicated by tests of small specimens but is not confirmed by available tests on structural sizes.
[6] Sold as hard maple.
[7] Also sold as Idaho white pine.
[8] Also sold as longleaf or shortleaf southern pine.

U. S. Department of Agriculture, Forest Service,
Forest Products Laboratory,
*Madison, Wis., September 19, 1941.*

TABLE 2.—*Working stresses for*

[For material used under

| Name of association and effective date of grading rules | Species | Commercial grade name | Beams and stringers [3] | | | | |
|---|---|---|---|---|---|---|---|
| | | | Paragraph reference [2] | Stress in extreme fiber | | Stress in horizontal shear | |
| | | | | Strength ratio | Stress | Strength ratio | Stress |
| | | | | *Percent* | *lb/in.²* | *Percent* | *lb/in.²* |
| California Redwood Association; July 15, 1936. | Redwood (California redwood). | Dense select all-heart structural | 174 | 82 | 1,400 | 86 | 80 |
| | | Select all-heart structural | 175 | 70 | 1,200 | 86 | 80 |
| National Hardwood Lumber Association; 1941. | Baldcypress (southern cypress). | 1400# f structural | 212 | 81 | 1,400 | 88 | 120 |
| | | 1100# f structural | 218 | 64 | 1,100 | 75 | 100 |
| | | 1200# c structural | | | | | |
| | | 1000# c structural | | | | | |
| Northeastern Lumber Manufacturers Association; Apr. 1, 1938. | Eastern spruce | 1200# f structural | | | | | |
| | | 1100# f structural | | | | | |
| | | 1000# f structural | | | | | |
| Northern Hemlock and Hardwood Manufacturers Association; June 27, 1941. | Eastern hemlock | Select structural | 23 | 75 | 1,100 | 75 | 70 |
| | | 1000 SG | | | | | |
| | | 900 SG | | | | | |
| | | 800 SG | | | | | |
| Northern Hemlock and Hardwood Manufacturers Association; July 23, 1941. | Red pine (Norway pine). | 1000 SG | | | | | |
| | | 900 SG | | | | | |
| | | 800 SG | | | | | |
| Southern Cypress Manufacturers Association; July 1940. | Baldcypress (tidewater red cypress). | 1,400 lb. f structural | 54 | 81 | 1,400 | 90 | 120 |
| | | 1,100 lb. f structural | 60 | 64 | 1,100 | 75 | 100 |
| | | 1,200 lb. c structural | | | | | |
| | | 1,000 lb. c structural | | | | | |
| Southern Pine Association; July 1, 1939. | Longleaf pine | Select structural longleaf | 389 | 86 | 2,000 | 58 | 100 |
| | | Prime structural longleaf | 392 | 77 | 1,800 | 58 | 100 |
| | | Merchantable structural longleaf. | 395 | 69 | 1,600 | 58 | 100 |
| | | Structural square edge and sound longleaf. | 398 | 69 | 1,600 | 58 | 100 |
| | | No. 1 structural longleaf | 401 | 60 | 1,400 | 58 | 100 |
| | | No. 1 longleaf dimension | | | | | |
| | | No. 2 longleaf—1050F | | | | | |
| | Shortleaf pine | Dense select structural | 468 | 86 | 2,000 | 58 | 100 |
| | | Dense structural | 471 | 77 | 1,800 | 58 | 100 |
| | | Dense structural square edge and sound. | 474 | 69 | 1,600 | 58 | 100 |
| | | Dense No. 1 structural | 477 | 60 | 1,400 | 58 | 100 |
| | | No. 1 dense dimension | | | | | |
| | | No. 1 dimension | | | | | |
| | | No. 2 dense 1050F dimension | | | | | |
| | | No. 2 medium grain 900F dimension. | | | | | |
| West Coast Lumbermen's Association; Jan. 1, 1941. | Douglas-fir | Dense select structural | 218, 302 | 77 | 1,800 | 75 | 105 |
| | | Select structural | 218 | 77 | 1,600 | 75 | 90 |
| | | 1,200 f | | | | | |
| | | 900 f | | | | | |

[1] When timber is used in a wet location or exposed to the weather, the working stresses shall be appropriately reduced. (See U. S. Dept. Agric. Miscellaneous Publication 185, "Guide to the Grading of Structural Timbers and the Determination of Working Stresses.") If the decay hazard is obviously high, treated material or the heartwood of a highly decay-resistant species should be employed.

[2] The numbers in this column refer to the paragraph numbers in the association grading rules given.

[3] Nominal dimensions 5 by 8 inches, and larger.

[4] Nominal dimensions 2 to 4 inches in thickness by 4 inches and wider.

[5] Nominal dimensions 4 by 4 inches, and larger (square or approximately square).

[6] Page number.

[7] Not applicable to widths 4 inches and less.

*various lumber-association grades*

continuously dry conditions] [1]

| Joists and planks [4] | | | | | Posts and timbers [5] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Paragraph reference [3] | Stress in extreme fiber | | Stress in horizontal shear | | Paragraph reference [3] | Compression parallel to grain | | Stress in compression perpendular to the grain | Modulus of elasticity |
| | Strength ratio | Stress | Strength ratio | Stress | | Strength ratio | Stress | | |
| | *Percent* | *lb/in.²* | *Percent* | *lb/in.²* | | *Percent* | *lb/in.²* | *lb/in.²* | *lb/in.²* |
| 174 | 72 | 1,400 | 86 | 80 | 177 | | | 267 | 1,200,000 |
| 175 | 64 | 1,200 | 86 | 80 | 177 | | | 267 | 1,200,000 |
| 114 | 71 | 1,400 | 90 | 120 | | | | 300 | 1,200,000 |
| 121 | 59 | 1,100 | 75 | 100 | | | | 300 | 1,200,000 |
| | | | | | 310 | 82 | 1,200 | 300 | 1,200,000 |
| | | | | | 316 | 68 | 1,000 | 300 | 1,200,000 |
| 107 | 71 | 1,200 | 80 | 90 | | | | 250 | 1,200,000 |
| 106 | 67 | 1,100 | 71 | 80 | | | | 250 | 1,200,000 |
| 105 | 63 | 1,000 | 71 | 80 | | | | 250 | 1,200,000 |
| 16 | 67 | 1,100 | 75 | 70 | 31 | 75 | 700 | 300 | 1,100,000 |
| [6] 46 | 63 | 1,000 | 50 | 46 | | | | 300 | 1,100,000 |
| [6] 46 | 58 | 900 | 50 | 46 | | | | 300 | 1,100,000 |
| [6] 46 | 53 | 800 | 50 | 46 | | | | 300 | 1,100,000 |
| [6] 45 | 63 | 1,000 | 50 | 56 | | | | 300 | 1,200,000 |
| [6] 45 | 58 | 900 | 50 | 56 | | | | 300 | 1,200,000 |
| [6] 45 | 53 | 800 | 50 | 56 | | | | 300 | 1,200,000 |
| 25 | 71 | 1,400 | 90 | 120 | | | | 300 | 1,200,000 |
| 31 | 59 | 1,100 | 75 | 100 | | | | 300 | 1,200,000 |
| | | | | | 82 | 82 | 1,200 | 300 | 1,200,000 |
| | | | | | 88 | 68 | 1,000 | 300 | 1,200,000 |
| 388 | 74 | 2,000 | 58 | 100 | 390 | 85 | 1,450 | 380 | 1,600,000 |
| 391 | 68 | 1,800 | 58 | 100 | 393 | 76 | 1,300 | 380 | 1,600,000 |
| 394 | 62 | 1,600 | 58 | 100 | 396 | 70 | 1,200 | 380 | 1,600,000 |
| 397 | 62 | 1,600 | 58 | 100 | 399 | 70 | 1,200 | 380 | 1,600,000 |
| 400 | 57 | 1,400 | 58 | 100 | 402 | 58 | 1,000 | 380 | 1,600,000 |
| 331 | 56 | 1,400 | | | | | | 380 | 1,600,000 |
| 333 | 45 | 1,050 | | | | | | 380 | 1,600,000 |
| 467 | 74 | 2,000 | 58 | 100 | 469 | 85 | 1,450 | 380 | 1,600,000 |
| 470 | 68 | 1,800 | 58 | 100 | 472 | 76 | 1,300 | 380 | 1,600,000 |
| 473 | 62 | 1,600 | 58 | 100 | 475 | 70 | 1,200 | 380 | 1,600,000 |
| 476 | 57 | 1,400 | 58 | 100 | 478 | 58 | 1,000 | 380 | 1,600,000 |
| 414 | 56 | 1,400 | | | | | | 380 | 1,600,000 |
| 413 | 56 | 1,200 | | | | | | 325 | 1,600,000 |
| 417 | 45 | 1,050 | | | | | | 380 | 1,600,000 |
| 416 | 45 | 900 | | | | | | 325 | 1,600,000 |
| 214, 302 | 69 | 1,800 | 75 | 105 | 210, 302 | 80 | 1,300 | 380 | 1,600,000 |
| 214 | 69 | 1,600 | 75 | 90 | 210 | 80 | 1,200 | 345 | 1,600,000 |
| 215 | 57 | [7] 1,200 | | | | | | 325 | 1,600,000 |
| 216 | 45 | [7] 900 | | | | | | 325 | 1,600,000 |

U. S. Department of Agriculture, Forest Service,
Forest Products Laboratory,
*Madison, Wis., September 29, 1941.*

TABLE 3.—*Working stresses* [1] *for various*

[For material used under

| Name of association and effective date of grading rules | Species | Commercial grade name | Paragraph reference [3] |
|---|---|---|---|
| California Redwood Association, May 1940 | Redwood (California redwood) | No. 1 Heart common, dimension, joists, and timbers. | 153 |
| | | No. 2 Common, dimension, joists, and timbers. | 150 and 154 |
| National Hardwood Lumber Association, January 1941. | Baldcypress (cypress) | No. 1 Common | 117 |
| Northeastern Lumber Manufacturers' Association, Apr. 1, 1938. | Eastern spruce | No. 1 (Merchantable) | 87 |
| | Balsam fir | No. 1 (Merchantable) | 87 |
| Northern Hemlock and Hardwood Manufacturers' Association, June 27, 1941. | Eastern hemlock (Hemlock) | No. 1 Common dimension | [5] 38 |
| | Tamarack | No. 1 Common dimension | [5] 38 |
| Northern Hemlock and Hardwood Manufacturers' Association, July 23, 1941. | Eastern white pine (Northern white pine) | No. 1 Dimension and timbers | [5] 42 |
| | Red pine (Norway pine) Eastern spruce | No. 1 Dimension and timbers | [5] 42 |
| Northern Pine Manufacturers' Association, May 1, 1939. | Eastern white pine (Northern white pine) | No. 1 Dimension and timbers | [5] 28 |
| | Jack pine | No. 1 Dimension and timbers | [5] 28 |
| | Balsam fir | No. 1 Dimension and timbers | [5] 28 |
| | Red pine (Norway pine) Eastern spruce | No. 1 Dimension and timbers | [5] 28 |
| | Tamarack | No. 1 Dimension and timbers | [5] 28 |
| Port Orford Cedar Lumber Association, Apr. 7, 1939. | Port Orford cedar | No. 1 Common dimension | [5] 11 |
| | | No. 2 Common | [5] 13 |
| Southern Cypress Manufacturers' Association, July 1940. | Baldcypress (Tidewater red cypress.) | No. 1 Common | 62 |
| Southern Pine Association, July 1, 1939 | Longleaf pine (Longleaf yellow pine.) | No. 2 Dimension | 332 |
| | Shortleaf pine (Shortleaf yellow pine.) | No. 2 Dimension | 415 |
| West Coast Lumbermen's Association, Jan. 1, 1941. | Douglas fir | Select merchantable dimension | 194 |
| | | No. 1 Dimension | 195 |
| | | No. 2 Dimension | 196 |
| | Western hemlock | Select merchantable dimension | 194 |
| | | No. 1 Dimension | 195 |
| | | No. 2 Dimension | 196 |
| | Sitka spruce | Select merchantable dimension | 194 |
| | | No. 1 Dimension | 195 |
| | | No. 2 Dimension | 196 |
| | Western redcedar | No. 1 Dimension, plank and small timber | 764 |
| | | No. 2 Dimension, plank and small timber | 765 |
| Western Pine Association, Apr. 1, 1939 | Engelmann spruce | No. 1 Dimension | 264 |
| | | No. 2 Dimension | 271 |
| | Ponderosa pine, sugarpine, western white pine (Idaho white pine). | No. 1 Dimension | 264 |
| | | No. 2 Dimension | 271 |
| | Western redcedar (red cedar) | No. 1 Dimension | 264 |
| | | No. 2 Dimension | 271 |
| | California incense-cedar (Incense-cedar) | No. 1 Dimension | 264 |
| | | No. 2 Dimension | 271 |
| | Douglas fir, Western larch (Larch-Douglas fir) | No. 1 Dimension | 264 |
| | | No. 2 Dimension | 271 |
| | White fir | No. 1 Dimension | 264 |
| | | No. 2 Dimension | 271 |

[1] The working stresses are based on evaluation of the effect of knots (of the sizes permitted by the association grading rules) in accordance with the principles set forth in U. S. Dept. Agric. Miscellaneous Publication 185, "Guide to the Grading of Structural Timbers and the Determination of Working Stresses" and supplement thereto (issued by the Forest Products Laboratory May 1940). It is assumed that in addition to limitation of knots, other essentials of strength grading as presented in Miscellaneous Publication 185 and the supplement (such as limitation of decay, slope of grain, shakes, checks, splits, wane and moisture content) are observed.

[2] When timber is used in a wet location or exposed to the weather, the working stresses shall be appropriately reduced (see U. S. Dept. Agric. Miscellaneous Publication No. 185, "Guide to the Grading of Structural Timbers and the Determination of Working Stresses"). If the decay hazard is obviously high, treated material or the heartwood of a highly decay-resistant species should be employed.

[3] The numbers in this column refer to grading rules given.

[4] Stresses for $l/d=11$ or less where d is the least dimension of a solid member or least dimension of each part of a composite member fastened with nails or other mechanical fastenings. If the parts of a composite member are adequately glued together with water-resistant glue, the composite number may be considered as a solid member.

[5] Page number.

*lumber-association grades of dimension*

continuously dry conditions] [2]

| Stress in extreme fiber in bending for depths of— | | | | | Stress [4] in compression parallel to grain for widths of— | | | | | Modulus of elasticity |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 in. | 6 in. | 8 in. | 10 in. | 12 in. | 4 in. | 6 in. | 8 in. | 10 in. | 12 in. | |
| *lb/in.*[2] | *lb/in.*[2] | *lb/in.*[2] | *lb/in.*[2] | *lb/in.*[2] | *lb/in.*[2] | *lb/in.*[2] | *lb/in.*[2] | *lb/in.*[2] | *lb/in.*[2] | *lb/in.*[2] |
| 580 | 970 | 970 | 1,160 | 1,110 | 690 | 930 | 1,050 | 1,070 | 1,090 | 1,200,000 |
| 340 | 510 | 610 | 800 | 820 | 430 | 690 | 670 | 770 | 850 | |
| 620 | 1,050 | 1,050 | 1,260 | 1,200 | 1,020 | 1,300 | 1,280 | 1,390 | 1,370 | 1,200,000 |
| 540 | 750 | 890 | 890 | 1,020 | 740 | 870 | 930 | 930 | 1,000 | 1,200,000 |
| 440 | 620 | 730 | 830 | 650 | 760 | 820 | 820 | 870 | | 1,000,000 |
| 530 | 660 | 700 | 890 | 890 | 650 | 700 | 730 | 820 | 820 | 1,100,000 |
| 580 | 720 | 770 | 970 | 970 | 930 | 1,010 | 1,050 | 1,170 | 1,170 | 1,300,000 |
| 430 | 540 | 580 | 650 | 730 | 690 | 750 | 780 | 840 | 880 | 1,000,000 |
| 530 | 660 | 700 | 800 | 890 | 740 | 800 | 840 | 900 | 930 | 1,200,000 |
| 430 | 540 | 580 | 650 | 730 | 690 | 750 | 780 | 840 | 880 | 1,000,000 |
| 430 | 540 | 580 | 650 | 730 | 650 | 700 | 730 | 790 | 820 | 1,000,000 |
| 530 | 660 | 700 | 800 | 890 | 740 | 800 | 840 | 900 | 930 | 1,200,000 |
| 580 | 720 | 770 | 870 | 970 | 930 | 1,010 | 1,050 | 1,130 | 1,170 | 1,300,000 |
| 530 | 750 | 890 | 890 | 890 | 830 | 980 | 1,050 | 1,050 | 1,050 | 1,500,000 |
| | 470 | 540 | 730 | 660 | 620 | 760 | 830 | 960 | 910 | |
| 620 | 1,050 | 1,050 | 1,260 | 1,200 | 1,020 | 1,300 | 1,280 | 1,390 | 1,370 | 1,200,000 |
| 490 | 540 | 510 | 540 | 540 | 880 | 880 | 860 | 860 | 860 | 1,600,000 |
| 420 | 460 | 440 | 460 | 460 | 750 | 750 | 730 | 730 | 730 | 1,600,000 |
| 1,240 | 1,420 | 1,510 | 1,570 | 1,600 | 1,300 | 1,390 | 1,440 | 1,460 | 1,480 | |
| 720 | 1,030 | 1,200 | 1,200 | 1,200 | 1,020 | 1,190 | 1,280 | 1,280 | 1,280 | 1,600,000 |
| 420 | 640 | 740 | 800 | 900 | 750 | 930 | 1,020 | 1,060 | 1,110 | |
| 1,080 | 1,230 | 1,310 | 1,360 | 1,390 | 1,070 | 1,140 | 1,180 | 1,190 | 1,210 | |
| 620 | 890 | 1,050 | 1,050 | 1,050 | 830 | 980 | 1,050 | 1,050 | 1,050 | 1,400,000 |
| 360 | 550 | 640 | 690 | 780 | 620 | 760 | 830 | 870 | 910 | |
| 910 | 1,040 | 1,110 | 1,150 | 1,170 | 950 | 1,010 | 1,040 | 1,060 | 1,080 | |
| 530 | 750 | 890 | 890 | 890 | 740 | 870 | 930 | 930 | 930 | 1,200,000 |
| 310 | 470 | 540 | 590 | 660 | 550 | 680 | 740 | 770 | 800 | |
| 430 | 730 | 730 | 730 | 730 | 650 | 830 | 820 | 820 | 790 | 1,000,000 |
| 250 | 380 | 440 | 480 | 540 | 480 | 590 | 650 | 680 | 700 | |
| 360 | 450 | 480 | 540 | 600 | 560 | 600 | 630 | 680 | 700 | 800,000 |
| 100 | 230 | 290 | 340 | 370 | 260 | 410 | 480 | 520 | 560 | |
| 430 | 540 | 580 | 650 | 730 | 700 | 760 | 780 | 840 | 880 | 1,000,000 |
| 120 | 280 | 350 | 410 | 440 | 320 | 520 | 600 | 650 | 700 | |
| 430 | 540 | 580 | 650 | 730 | 650 | 700 | 730 | 790 | 820 | 1,000,000 |
| 120 | 280 | 350 | 410 | 440 | 300 | 480 | 560 | 610 | 650 | |
| 430 | 540 | 580 | 650 | 730 | 700 | 760 | 780 | 840 | 880 | 800,000 |
| 120 | 280 | 350 | 410 | 440 | 320 | 520 | 600 | 650 | 700 | |
| 530 | 660 | 700 | 800 | 890 | 740 | 800 | 840 | 900 | 930 | 1,200,000 |
| 150 | 340 | 420 | 500 | 540 | 340 | 550 | 640 | 690 | 740 | |
| 530 | 660 | 700 | 800 | 890 | 650 | 700 | 730 | 790 | 820 | 1,100,000 |
| 150 | 340 | 420 | 500 | 540 | 300 | 480 | 560 | 610 | 650 | |

U. S. Department of Agriculture, Forest Service,
Forest Products Laboratory,
*Madison, Wis., revised February 10, 1942*

TABLE 4.—*Maximum spans* [1] *for floor joists of one-*

[45 lb/ft.² total live

| Size (nominal) | Spacing | Span limited by deflection when modulus of elasticity in pounds per square inch is— | | | | | | | | | | Span [2] determined by bending when fiber stress in pounds per square inch is— | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1,000,000 | | 1,100,000 | | 1,200,000 | | 1,400,000 | | 1,600,000 | | 200 | | 300 | | 400 | | 500 | | 600 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×6 | 12 | 9 | 8 | 9 | 11 | 10 | 3 | 10 | 9 | 11 | 3 | 5 | 0 | 6 | 2 | 7 | 2 | 8 | 0 | 8 | 9 |
| | 16 | 8 | 9 | 9 | 0 | 9 | 4 | 9 | 9 | 10 | 3 | 4 | 4 | 5 | 4 | 6 | 2 | 6 | 11 | 7 | 7 |
| | 24 | 7 | 8 | 7 | 11 | 8 | 1 | 8 | 7 | 8 | 11 | 3 | 7 | 4 | 4 | 5 | 0 | 5 | 8 | 6 | 2 |
| 2×8 | 12 | 12 | 10 | 13 | 3 | 13 | 8 | 14 | 4 | 15 | 0 | 6 | 9 | 8 | 3 | 9 | 6 | 10 | 7 | 11 | 8 |
| | 16 | 11 | 8 | 12 | 0 | 12 | 5 | 13 | 1 | 13 | 8 | 5 | 10 | 7 | 2 | 8 | 3 | 9 | 2 | 10 | 1 |
| | 24 | 10 | 2 | 10 | 6 | 10 | 10 | 11 | 5 | 11 | 11 | 4 | 9 | 5 | 10 | 6 | 9 | 7 | 6 | 8 | 3 |
| 2×10 | 12 | 16 | 3 | 16 | 9 | 17 | 3 | 18 | 2 | 19 | 0 | 8 | 6 | 10 | 5 | 12 | 0 | 13 | 5 | 14 | 9 |
| | 16 | 14 | 9 | 15 | 3 | 15 | 8 | 16 | 6 | 17 | 3 | 7 | 4 | 9 | 0 | 10 | 5 | 11 | 8 | 12 | 9 |
| | 24 | 12 | 11 | 13 | 4 | 13 | 9 | 14 | 5 | 15 | 1 | 6 | 0 | 7 | 4 | 8 | 6 | 9 | 6 | 10 | 5 |
| 2×12 | 12 | 19 | 8 | 20 | 4 | 20 | 11 | 22 | 0 | 23 | 0 | 10 | 4 | 12 | 7 | 14 | 7 | 16 | 3 | 17 | 10 |
| | 16 | 17 | 11 | 18 | 6 | 19 | 0 | 20 | 0 | 20 | 11 | 8 | 11 | 10 | 11 | 12 | 7 | 14 | 1 | 15 | 5 |
| | 24 | 15 | 7 | 16 | 2 | 16 | 7 | 17 | 6 | 18 | 3 | 7 | 3 | 8 | 11 | 10 | 4 | 11 | 6 | 12 | 7 |
| 2×14 | 12 | 23 | 1 | 23 | 10 | 24 | 7 | 25 | 10 | 27 | 0 | 12 | 1 | 14 | 10 | 17 | 1 | 19 | 1 | 20 | 11 |
| | 16 | 21 | 0 | 21 | 8 | 22 | 4 | 23 | 6 | 24 | 7 | 10 | 6 | 12 | 10 | 14 | 10 | 16 | 7 | 18 | 2 |
| | 24 | 18 | 4 | 18 | 11 | 19 | 6 | 20 | 6 | 21 | 5 | 8 | 7 | 10 | 6 | 12 | 1 | 13 | 6 | 14 | 10 |
| 3×6 | 12 | 11 | 4 | 11 | 8 | 12 | 0 | 12 | 8 | 13 | 3 | 6 | 5 | 7 | 10 | 9 | 1 | 10 | 2 | 11 | 1 |
| | 16 | 10 | 3 | 10 | 7 | 10 | 11 | 11 | 6 | 12 | 0 | 5 | 7 | 6 | 10 | 7 | 10 | 8 | 9 | 9 | 7 |
| | 24 | 9 | 0 | 9 | 3 | 9 | 6 | 10 | 0 | 10 | 6 | 4 | 6 | 5 | 7 | 6 | 5 | 7 | 2 | 7 | 10 |
| 3×8 | 12 | 15 | 1 | 15 | 7 | 16 | 0 | 16 | 10 | 17 | 7 | 8 | 6 | 10 | 6 | 12 | 1 | 13 | 6 | 14 | 9 |
| | 16 | 13 | 8 | 14 | 2 | 14 | 7 | 15 | 4 | 16 | 0 | 7 | 5 | 9 | 1 | 10 | 5 | 11 | 8 | 12 | 10 |
| | 24 | 11 | 11 | 12 | 4 | 12 | 8 | 13 | 4 | 14 | 0 | 6 | 0 | 7 | 5 | 8 | 6 | 9 | 7 | 10 | 6 |
| 3×10 | 12 | 19 | 1 | 19 | 8 | 20 | 3 | 21 | 4 | 22 | 4 | 10 | 10 | 13 | 3 | 15 | 4 | 17 | 1 | 18 | 9 |
| | 16 | 17 | 4 | 17 | 11 | 18 | 5 | 19 | 5 | 20 | 3 | 9 | 4 | 11 | 6 | 13 | 3 | 14 | 10 | 16 | 3 |
| | 24 | 15 | 2 | 15 | 8 | 16 | 1 | 16 | 11 | 17 | 9 | 7 | 8 | 9 | 4 | 10 | 10 | 12 | 1 | 13 | 3 |
| 3×12 | 12 | 23 | 1 | 23 | 10 | 24 | 7 | 25 | 10 | 27 | 0 | 13 | 1 | 16 | 0 | 18 | 6 | 20 | 8 | 22 | 8 |
| | 16 | 21 | 0 | 21 | 8 | 22 | 4 | 23 | 6 | 24 | 7 | 11 | 4 | 13 | 11 | 16 | 0 | 17 | 11 | 19 | 8 |
| | 24 | 18 | 4 | 18 | 11 | 19 | 6 | 20 | 6 | 21 | 5 | 9 | 3 | 11 | 4 | 13 | 1 | 14 | 8 | 16 | 0 |
| 3×14 | 12 | 27 | 1 | 28 | 0 | 28 | 10 | 30 | 4 | 31 | 9 | 15 | 4 | 18 | 10 | 21 | 9 | 24 | 4 | 26 | 7 |
| | 16 | 24 | 8 | 25 | 5 | 26 | 2 | 27 | 7 | 28 | 10 | 13 | 4 | 16 | 4 | 18 | 10 | 21 | 1 | 23 | 1 |
| | 24 | 21 | 6 | 22 | 3 | 22 | 10 | 24 | 1 | 25 | 2 | 10 | 10 | 13 | 4 | 15 | 4 | 17 | 2 | 18 | 10 |

[1] This table is based on FHA design recommendations as follows:

(a) Where fiber stress is the controlling factor, the assumed total design load is 45 lb/ft². For first floors of 1- and 2-story houses and for all floors of multiple dwellings, it is assumed that the superimposed load is 40 lb/ft² and the dead load 5 lb/ft²; for second floors of 2-story houses the superimposed load is 30 lb/ft² and the dead load 15 lb/ft². These loading assumptions permit the same design load basis for first and second floors, and for multiple dwellings where plaster is not used.

(b) When deflection is the controlling factor, the deflection limitation of 1/360 of the span is based on an assumed total load of 40 lb/ft² for both the first and second floors, and for multiple dwellings.

[2] Maximum spans for working stresses which are between those tabulated shall be determined by interpolation.

and dead load]

Span [3] determined by bending when fiber stress in pounds per square inch is—Continued

| 700 | | 800 | | 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 9 | 5 | 10 | 1 | 10 | 8 | 11 | 3 | 11 | 10 | 12 | 4 | 12 | 10 | 13 | 4 | 13 | 10 | 14 | 3 | 14 | 8 | 15 | 1 |
| 8 | 2 | 8 | 9 | 9 | 3 | 9 | 9 | 10 | 3 | 10 | 8 | 11 | 2 | 11 | 7 | 11 | 11 | 12 | 4 | 12 | 9 | 13 | 1 |
| 6 | 8 | 7 | 2 | 7 | 7 | 8 | 0 | 8 | 4 | 8 | 9 | 9 | 1 | 9 | 5 | 9 | 9 | 10 | 1 | 10 | 5 | 10 | 8 |
| 12 | 7 | 13 | 5 | 14 | 3 | 15 | 0 | 15 | 9 | 16 | 5 | 17 | 2 | 17 | 9 | 18 | 5 | 19 | 0 | 19 | 7 | 20 | 2 |
| 10 | 11 | 11 | 8 | 12 | 4 | 13 | 0 | 13 | 8 | 14 | 3 | 14 | 10 | 15 | 5 | 15 | 11 | 16 | 5 | 17 | 0 | 17 | 5 |
| 8 | 11 | 9 | 6 | 10 | 1 | 10 | 7 | 11 | 2 | 11 | 8 | 12 | 1 | 12 | 7 | 13 | 0 | 13 | 5 | 13 | 10 | 14 | 3 |
| 15 | 11 | 17 | 0 | 18 | 1 | 19 | 0 | 19 | 11 | 20 | 10 | 21 | 8 | 22 | 6 | 23 | 4 | 24 | 1 | 24 | 10 | 25 | 6 |
| 13 | 9 | 14 | 9 | 15 | 8 | 16 | 6 | 17 | 3 | 18 | 1 | 18 | 9 | 19 | 6 | 20 | 2 | 20 | 10 | 21 | 6 | 22 | 1 |
| 11 | 3 | 12 | 0 | 12 | 9 | 13 | 5 | 14 | 1 | 14 | 9 | 15 | 4 | 15 | 11 | 16 | 6 | 17 | 0 | 17 | 7 | 18 | 1 |
| 19 | 3 | 20 | 7 | 21 | 10 | 23 | 0 | 24 | 2 | 25 | 3 | 26 | 3 | 27 | 3 | 28 | 3 | 29 | 2 | 30 | 0 | 30 | 11 |
| 16 | 8 | 17 | 10 | 18 | 11 | 19 | 11 | 20 | 11 | 21 | 10 | 22 | 9 | 23 | 7 | 24 | 5 | 25 | 3 | 26 | 0 | 26 | 9 |
| 13 | 8 | 14 | 7 | 15 | 5 | 16 | 3 | 17 | 1 | 17 | 10 | 18 | 7 | 19 | 3 | 19 | 11 | 20 | 7 | 21 | 3 | 21 | 10 |
| 22 | 8 | 24 | 2 | 25 | 8 | 27 | 1 | 28 | 4 | 29 | 7 | 30 | 10 | 32 | 0 | 33 | 1 | 34 | 2 | 35 | 3 | 36 | 3 |
| 19 | 7 | 20 | 11 | 22 | 3 | 23 | 5 | 24 | 7 | 25 | 8 | 26 | 8 | 27 | 9 | 28 | 8 | 29 | 7 | 30 | 6 | 31 | 5 |
| 16 | 0 | 17 | 1 | 18 | 2 | 19 | 1 | 20 | 1 | 20 | 11 | 21 | 10 | 22 | 8 | 23 | 5 | 24 | 2 | 24 | 11 | 25 | 8 |
| 12 | 0 | 12 | 10 | 13 | 7 | 14 | 4 | 15 | 0 | 15 | 8 | 16 | 4 | 16 | 11 | 17 | 6 | 18 | 1 | 18 | 8 | 19 | 3 |
| 10 | 5 | 11 | 1 | 11 | 9 | 12 | 5 | 13 | 0 | 13 | 7 | 14 | 2 | 14 | 8 | 15 | 2 | 15 | 8 | 16 | 2 | 16 | 8 |
| 8 | 6 | 9 | 1 | 9 | 7 | 10 | 2 | 10 | 7 | 11 | 1 | 11 | 7 | 12 | 0 | 12 | 5 | 12 | 10 | 13 | 2 | 13 | 7 |
| 16 | 0 | 17 | 1 | 18 | 1 | 19 | 1 | 20 | 0 | 20 | 11 | 21 | 9 | 22 | 7 | 23 | 5 | 24 | 2 | 24 | 11 | 25 | 7 |
| 13 | 10 | 14 | 9 | 15 | 8 | 16 | 6 | 17 | 4 | 18 | 1 | 18 | 10 | 19 | 7 | 20 | 3 | 20 | 11 | 21 | 7 | 22 | 2 |
| 11 | 4 | 12 | 1 | 12 | 10 | 13 | 6 | 14 | 2 | 14 | 9 | 15 | 5 | 16 | 0 | 16 | 6 | 17 | 1 | 17 | 7 | 18 | 1 |
| 20 | 3 | 21 | 8 | 22 | 11 | 24 | 2 | 25 | 4 | 26 | 6 | 27 | 7 | 28 | 7 | 29 | 7 | 30 | 7 | 31 | 6 | 32 | 5 |
| 17 | 6 | 18 | 9 | 19 | 10 | 20 | 11 | 22 | 0 | 22 | 11 | 23 | 11 | 24 | 9 | 25 | 8 | 26 | 6 | 27 | 4 | 28 | 1 |
| 14 | 4 | 15 | 4 | 16 | 3 | 17 | 1 | 17 | 11 | 18 | 9 | 19 | 6 | 20 | 3 | 20 | 11 | 21 | 8 | 22 | 4 | 22 | 11 |
| 24 | 6 | 26 | 2 | 27 | 9 | 29 | 3 | 30 | 8 | 32 | 1 | 33 | 5 | 34 | 8 | 35 | 10 | 37 | 0 | 38 | 2 | 39 | 3 |
| 21 | 3 | 22 | 8 | 24 | 1 | 25 | 4 | 26 | 7 | 27 | 9 | 28 | 11 | 30 | 0 | 31 | 1 | 32 | 1 | 33 | 1 | 34 | 0 |
| 17 | 4 | 18 | 6 | 19 | 8 | 20 | 8 | 21 | 9 | 22 | 8 | 23 | 7 | 24 | 6 | 25 | 4 | 26 | 2 | 27 | 0 | 27 | 9 |
| 28 | 9 | 30 | 9 | 32 | 7 | 34 | 4 | 36 | 1 | 37 | 8 | 39 | 2 | 40 | 8 | 42 | 1 | 43 | 6 | 44 | 10 | 46 | 1 |
| 24 | 11 | 26 | 7 | 28 | 3 | 29 | 9 | 31 | 3 | 32 | 7 | 33 | 11 | 35 | 3 | 36 | 5 | 37 | 8 | 38 | 10 | 39 | 11 |
| 20 | 4 | 21 | 9 | 23 | 1 | 24 | 4 | 25 | 6 | 26 | 7 | 27 | 9 | 28 | 9 | 29 | 9 | 30 | 9 | 31 | 8 | 32 | 7 |

U. S. Department of Agriculture, Forest Service,
Forest Products Laboratory,
*Madison, Wis., September 29, 1941;*
*revised December 15, 1941.*

TABLE 5.—*Maximum spans* [1] *for*

[55 lb/ft² total live

| Size (nominal) | Spacing | Span limited by deflection when modulus of elasticity in pounds per square inch is— | | | | | | | | Span [2] determined by bending when fiber stress in pounds per square inch is— | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1,000,000 | | 1,100,000 | | 1,200,000 | | 1,400,000 | | 1,600,000 | | 200 | | 300 | | 400 | | 500 | | 600 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×6 | 12 | 9 | 8 | 9 | 11 | 10 | 3 | 10 | 9 | 11 | 3 | 4 | 7 | 5 | 7 | 6 | 5 | 7 | 2 | 7 | 11 |
| | 16 | 8 | 9 | 9 | 0 | 9 | 4 | 9 | 9 | 10 | 3 | 3 | 11 | 4 | 10 | 5 | 7 | 6 | 3 | 6 | 10 |
| | 24 | 7 | 8 | 7 | 11 | 8 | 1 | 8 | 7 | 8 | 11 | 3 | 3 | 3 | 11 | 4 | 7 | 5 | 1 | 5 | 7 |
| 2×8 | 12 | 12 | 10 | 13 | 3 | 13 | 8 | 14 | 4 | 15 | 0 | 6 | 1 | 7 | 5 | 8 | 7 | 9 | 7 | 10 | 6 |
| | 16 | 11 | 8 | 12 | 0 | 12 | 5 | 13 | 1 | 13 | 8 | 5 | 3 | 6 | 5 | 7 | 5 | 8 | 4 | 9 | 1 |
| | 24 | 10 | 2 | 10 | 6 | 10 | 10 | 11 | 5 | 11 | 11 | 4 | 4 | 5 | 3 | 6 | 1 | 6 | 10 | 7 | 5 |
| 2×10 | 12 | 16 | 3 | 16 | 9 | 17 | 3 | 18 | 2 | 19 | 0 | 7 | 8 | 9 | 5 | 10 | 11 | 12 | 2 | 13 | 4 |
| | 16 | 14 | 9 | 15 | 3 | 15 | 8 | 16 | 6 | 17 | 3 | 6 | 8 | 8 | 2 | 9 | 5 | 10 | 6 | 11 | 7 |
| | 24 | 12 | 11 | 13 | 4 | 13 | 9 | 14 | 5 | 15 | 1 | 5 | 5 | 6 | 8 | 7 | 8 | 8 | 7 | 9 | 5 |
| 2×12 | 12 | 19 | 8 | 20 | 4 | 20 | 11 | 22 | 0 | 23 | 0 | 9 | 4 | 11 | 5 | 13 | 2 | 14 | 9 | 16 | 2 |
| | 16 | 17 | 11 | 18 | 6 | 19 | 0 | 20 | 0 | 20 | 11 | 8 | 1 | 9 | 11 | 11 | 5 | 12 | 9 | 14 | 0 |
| | 24 | 15 | 7 | 16 | 2 | 16 | 7 | 17 | 6 | 18 | 3 | 6 | 7 | 8 | 1 | 9 | 4 | 10 | 5 | 11 | 5 |
| 2×14 | 12 | 23 | 1 | 23 | 10 | 24 | 7 | 25 | 10 | 27 | 0 | 10 | 11 | 13 | 5 | 15 | 6 | 17 | 4 | 18 | 11 |
| | 16 | 21 | 0 | 21 | 8 | 22 | 4 | 23 | 6 | 24 | 7 | 9 | 6 | 11 | 7 | 13 | 5 | 15 | 0 | 16 | 5 |
| | 24 | 18 | 4 | 18 | 11 | 19 | 6 | 20 | 6 | 21 | 5 | 7 | 9 | 9 | 6 | 10 | 11 | 12 | 3 | 13 | 5 |
| 3×6 | 12 | 11 | 4 | 11 | 8 | 12 | 0 | 12 | 8 | 13 | 3 | 5 | 10 | 7 | 1 | 8 | 2 | 9 | 2 | 10 | 0 |
| | 16 | 10 | 3 | 10 | 7 | 10 | 11 | 11 | 6 | 12 | 0 | 5 | 0 | 6 | 2 | 7 | 1 | 7 | 11 | 8 | 8 |
| | 24 | 9 | 0 | 9 | 3 | 9 | 6 | 10 | 0 | 10 | 6 | 4 | 1 | 5 | 0 | 5 | 10 | 6 | 6 | 7 | 1 |
| 3×8 | 12 | 15 | 1 | 15 | 7 | 16 | 0 | 16 | 10 | 17 | 7 | 7 | 9 | 9 | 6 | 10 | 11 | 12 | 3 | 13 | 5 |
| | 16 | 13 | 8 | 14 | 2 | 14 | 7 | 15 | 4 | 16 | 0 | 6 | 8 | 8 | 2 | 9 | 6 | 10 | 7 | 11 | 7 |
| | 24 | 11 | 11 | 12 | 4 | 12 | 8 | 13 | 4 | 14 | 0 | 5 | 6 | 6 | 8 | 7 | 9 | 8 | 8 | 9 | 6 |
| 3×10 | 12 | 19 | 1 | 19 | 8 | 20 | 3 | 21 | 4 | 22 | 4 | 9 | 9 | 12 | 0 | 13 | 10 | 15 | 6 | 16 | 11 |
| | 16 | 17 | 4 | 17 | 11 | 18 | 5 | 19 | 5 | 20 | 3 | 8 | 6 | 10 | 5 | 12 | 0 | 13 | 5 | 14 | 8 |
| | 24 | 15 | 2 | 15 | 8 | 16 | 1 | 16 | 11 | 17 | 9 | 6 | 11 | 8 | 6 | 9 | 9 | 10 | 11 | 12 | 0 |
| 3×12 | 12 | 23 | 1 | 23 | 10 | 24 | 7 | 25 | 10 | 27 | 0 | 11 | 10 | 14 | 6 | 16 | 9 | 18 | 9 | 20 | 6 |
| | 16 | 21 | 0 | 21 | 8 | 22 | 4 | 23 | 6 | 24 | 7 | 10 | 3 | 12 | 7 | 14 | 6 | 16 | 3 | 17 | 9 |
| | 24 | 18 | 4 | 18 | 11 | 19 | 6 | 20 | 6 | 21 | 5 | 8 | 4 | 10 | 3 | 11 | 10 | 13 | 3 | 14 | 6 |
| 3×14 | 12 | 27 | 1 | 28 | 0 | 28 | 10 | 30 | 4 | 31 | 9 | 13 | 11 | 17 | 0 | 19 | 8 | 22 | 0 | 24 | 1 |
| | 16 | 24 | 8 | 25 | 5 | 26 | 2 | 27 | 7 | 28 | 10 | 12 | 0 | 14 | 9 | 17 | 0 | 19 | 0 | 20 | 10 |
| | 24 | 21 | 6 | 22 | 3 | 22 | 10 | 24 | 1 | 25 | 2 | 9 | 10 | 12 | 0 | 13 | 11 | 15 | 7 | 17 | 0 |

[1] This table is based on FHA design recommendations as follows:

(a) When fiber stress is the controlling factor, the assumed total design load is 55 lb/ft², composed of 40 lb/ft² superimposed load for all floors, and 15 lb/ft² dead load for joists and plaster.

(b) When deflection is the controlling factor, the deflection limitation of 1/360 of the span is based on an assumed total load of 40 lb/ft².

Maximum spans for working stresses which are between those tabulated shall be determined by interpolation.

and dead load]

Span [2] determined by bending when fiber stress in pounds per square inch is—Continued

| 700 | | 800 | | 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 8 | 6 | 9 | 1 | 9 | 8 | 10 | 2 | 10 | 8 | 11 | 2 | 11 | 7 | 12 | 1 | 12 | 6 | 12 | 11 | 13 | 3 | 13 | 8 |
| 7 | 5 | 7 | 11 | 8 | 4 | 8 | 10 | 9 | 3 | 9 | 8 | 10 | 1 | 10 | 5 | 10 | 10 | 11 | 2 | 11 | 6 | 11 | 10 |
| 6 | 0 | 6 | 5 | 6 | 10 | 7 | 2 | 7 | 7 | 7 | 11 | 8 | 3 | 8 | 6 | 8 | 10 | 9 | 1 | 9 | 5 | 9 | 8 |
| 11 | 4 | 12 | 2 | 12 | 11 | 13 | 7 | 14 | 3 | 14 | 11 | 15 | 6 | 16 | 1 | 16 | 8 | 17 | 2 | 17 | 9 | 18 | 3 |
| 9 | 10 | 10 | 6 | 11 | 2 | 11 | 9 | 12 | 4 | 12 | 11 | 13 | 5 | 13 | 11 | 14 | 5 | 14 | 11 | 15 | 4 | 15 | 9 |
| 8 | 0 | 8 | 7 | 9 | 1 | 9 | 7 | 10 | 1 | 10 | 6 | 10 | 11 | 11 | 4 | 11 | 9 | 12 | 2 | 12 | 6 | 12 | 11 |
| 14 | 5 | 15 | 5 | 16 | 4 | 17 | 3 | 18 | 1 | 18 | 10 | 19 | 7 | 20 | 4 | 21 | 1 | 21 | 9 | 22 | 5 | 23 | 1 |
| 12 | 6 | 13 | 4 | 14 | 2 | 14 | 11 | 15 | 8 | 16 | 4 | 17 | 0 | 17 | 8 | 18 | 3 | 18 | 10 | 19 | 5 | 20 | 0 |
| 10 | 2 | 10 | 11 | 11 | 7 | 12 | 2 | 12 | 9 | 13 | 4 | 13 | 11 | 14 | 5 | 14 | 11 | 15 | 5 | 15 | 10 | 16 | 4 |
| 17 | 5 | 18 | 8 | 19 | 9 | 20 | 10 | 21 | 10 | 22 | 10 | 23 | 9 | 24 | 8 | 25 | 6 | 26 | 4 | 27 | 2 | 27 | 11 |
| 15 | 1 | 16 | 2 | 17 | 1 | 18 | 1 | 18 | 11 | 19 | 9 | 20 | 7 | 21 | 4 | 22 | 1 | 22 | 10 | 23 | 6 | 24 | 3 |
| 12 | 4 | 13 | 2 | 14 | 0 | 14 | 9 | 15 | 5 | 16 | 2 | 16 | 10 | 17 | 5 | 18 | 1 | 18 | 8 | 19 | 3 | 19 | 9 |
| 20 | 6 | 21 | 11 | 23 | 2 | 24 | 6 | 25 | 8 | 26 | 10 | 27 | 11 | 28 | 11 | 29 | 11 | 30 | 11 | 31 | 11 | 32 | 10 |
| 17 | 9 | 18 | 11 | 20 | 1 | 21 | 2 | 22 | 3 | 23 | 2 | 24 | 2 | 25 | 1 | 25 | 11 | 26 | 10 | 27 | 7 | 28 | 5 |
| 14 | 6 | 15 | 6 | 16 | 5 | 17 | 4 | 18 | 2 | 18 | 11 | 19 | 9 | 20 | 6 | 21 | 2 | 21 | 11 | 22 | 7 | 23 | 2 |
| 10 | 10 | 11 | 7 | 12 | 3 | 12 | 11 | 13 | 7 | 14 | 2 | 14 | 9 | 15 | 4 | 15 | 10 | 16 | 5 | 16 | 11 | 17 | 5 |
| 9 | 5 | 10 | 0 | 10 | 8 | 11 | 3 | 11 | 9 | 12 | 3 | 12 | 9 | 13 | 3 | 13 | 9 | 14 | 2 | 14 | 8 | 15 | 1 |
| 7 | 8 | 8 | 2 | 8 | 8 | 9 | 2 | 9 | 7 | 10 | 0 | 10 | 5 | 10 | 10 | 11 | 3 | 11 | 7 | 11 | 11 | 12 | 3 |
| 14 | 5 | 15 | 5 | 16 | 5 | 17 | 3 | 18 | 1 | 18 | 11 | 19 | 8 | 20 | 5 | 21 | 2 | 21 | 10 | 22 | 6 | 23 | 2 |
| 12 | 6 | 13 | 5 | 14 | 2 | 14 | 11 | 15 | 8 | 16 | 5 | 17 | 1 | 17 | 8 | 18 | 4 | 18 | 11 | 19 | 6 | 20 | 1 |
| 10 | 3 | 10 | 11 | 11 | 7 | 12 | 3 | 12 | 10 | 13 | 5 | 13 | 11 | 14 | 5 | 14 | 11 | 15 | 5 | 15 | 11 | 16 | 5 |
| 18 | 4 | 19 | 7 | 20 | 9 | 21 | 11 | 22 | 11 | 24 | 0 | 24 | 11 | 25 | 11 | 26 | 10 | 27 | 8 | 28 | 6 | 29 | 4 |
| 15 | 10 | 16 | 11 | 18 | 0 | 18 | 11 | 19 | 10 | 20 | 9 | 21 | 7 | 22 | 5 | 23 | 2 | 24 | 0 | 24 | 8 | 25 | 5 |
| 12 | 11 | 13 | 10 | 14 | 8 | 15 | 6 | 16 | 3 | 16 | 11 | 17 | 8 | 18 | 4 | 18 | 11 | 19 | 7 | 20 | 2 | 20 | 9 |
| 22 | 2 | 23 | 8 | 25 | 1 | 26 | 6 | 27 | 9 | 29 | 0 | 30 | 2 | 31 | 4 | 32 | 5 | 33 | 6 | 34 | 6 | 35 | 6 |
| 19 | 2 | 20 | 6 | 21 | 9 | 22 | 11 | 24 | 1 | 25 | 1 | 26 | 2 | 27 | 2 | 28 | 1 | 29 | 0 | 29 | 11 | 30 | 9 |
| 15 | 8 | 16 | 9 | 17 | 9 | 18 | 9 | 19 | 8 | 20 | 6 | 21 | 4 | 22 | 2 | 22 | 11 | 23 | 8 | 24 | 5 | 25 | 1 |
| 26 | 0 | 27 | 10 | 29 | 6 | 31 | 1 | 32 | 7 | 34 | 1 | 35 | 5 | 36 | 9 | 38 | 1 | 39 | 4 | 40 | 6 | 41 | 8 |
| 22 | 6 | 24 | 1 | 25 | 6 | 26 | 11 | 28 | 3 | 29 | 6 | 30 | 8 | 31 | 10 | 33 | 0 | 34 | 1 | 35 | 1 | 36 | 1 |
| 18 | 5 | 19 | 8 | 20 | 10 | 22 | 0 | 23 | 1 | 24 | 1 | 25 | 1 | 26 | 0 | 26 | 11 | 27 | 10 | 28 | 8 | 29 | 6 |

U. S. Department of Agriculture, Forest Service,
Forest Products Laboratory,
*Madison, Wis., September 29, 1941;*
*revised December 15, 1941.*

TABLE 6.—*Maximum*

[10 lb/ft² total

| Size (nominal) | Spacing | Span limited by deflection when modulus of elasticity in pounds per square inch is— | | | | | | | | | | Span [2] determined by bending when fiber stress in pounds per square inch is— | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1,000,000 | | 1,100,000 | | 1,200,000 | | 1,400,000 | | 1,600,000 | | 200 | | 300 | | 400 | | 500 | | 600 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2 × 4 | 12 | 9 | 10 | 10 | 2 | 10 | 6 | 11 | 0 | 11 | 6 | 6 | 11 | 8 | 5 | 9 | 9 | 10 | 11 | 11 | 11 |
| | 16 | 8 | 11 | 9 | 3 | 9 | 6 | 10 | 0 | 10 | 6 | 6 | 0 | 7 | 4 | 8 | 5 | 9 | 5 | 10 | 4 |
| | 24 | 7 | 10 | 8 | 1 | 8 | 4 | 8 | 9 | 9 | 2 | 4 | 10 | 6 | 0 | 6 | 11 | 7 | 8 | 8 | 5 |
| 2 × 6 | 12 | 15 | 3 | 15 | 9 | 16 | 3 | 17 | 1 | 17 | 11 | 10 | 8 | 13 | 1 | 15 | 1 | 16 | 11 | 18 | 6 |
| | 16 | 13 | 11 | 14 | 4 | 14 | 9 | 15 | 6 | 16 | 3 | 9 | 3 | 11 | 4 | 13 | 1 | 14 | 8 | 16 | 0 |
| | 24 | 12 | 2 | 12 | 6 | 12 | 11 | 13 | 7 | 14 | 2 | 7 | 7 | 9 | 3 | 10 | 8 | 11 | 11 | 13 | 1 |
| 2×8 | 12 | 20 | 5 | 21 | 0 | 21 | 8 | 22 | 10 | 23 | 10 | 14 | 3 | 17 | 5 | 20 | 2 | 22 | 6 | 24 | 8 |
| | 16 | 18 | 6 | 19 | 1 | 19 | 8 | 20 | 9 | 21 | 8 | 12 | 4 | 15 | 1 | 17 | 5 | 19 | 6 | 21 | 5 |
| | 24 | 16 | 2 | 16 | 8 | 17 | 2 | 18 | 1 | 18 | 11 | 10 | 1 | 12 | 4 | 14 | 3 | 15 | 11 | 17 | 5 |
| 2×10 | 12 | 25 | 10 | 26 | 8 | 27 | 5 | 28 | 11 | 30 | 2 | 18 | 1 | 22 | 1 | 25 | 6 | 28 | 7 | 31 | 3 |
| | 16 | 23 | 5 | 24 | 3 | 24 | 11 | 26 | 3 | 27 | 5 | 15 | 8 | 19 | 2 | 22 | 1 | 24 | 9 | 27 | 1 |
| | 24 | 20 | 6 | 21 | 2 | 21 | 9 | 22 | 11 | 24 | 0 | 12 | 9 | 15 | 8 | 18 | 1 | 20 | 2 | 22 | 1 |
| 2×12 | 12 | 31 | 3 | 32 | 3 | 33 | 2 | 34 | 11 | 36 | 7 | 21 | 10 | 26 | 9 | 30 | 11 | 34 | 7 | 37 | 10 |
| | 16 | 28 | 5 | 29 | 4 | 30 | 2 | 31 | 9 | 33 | 2 | 18 | 11 | 23 | 2 | 26 | 9 | 29 | 11 | 32 | 9 |
| | 24 | 24 | 10 | 25 | 7 | 26 | 4 | 27 | 9 | 29 | 0 | 15 | 5 | 18 | 11 | 21 | 10 | 24 | 5 | 26 | 9 |

[1] This table is based on FHA design recommendations as follows:
(a) Where the fiber stress is the controlling factor, the assumed total design load is 10 lb/ft².
(b) When deflection is the controlling factor, the deflection limitation of 1/360 of the span is based on an assumed total load of 10 lb/ft².
[2] Maximum spans for working stresses which are between those tabulated shall be determined by interpolation.

TABLE 7.—*Maximum spans* [1]

[30 lb/ft² total live and dead

| Size (nominal) | Spacing | Span limited by deflection when modulus of elasticity in pounds per square inch is— | | | | | | | | | | Span [2] determined by bending when fiber stress in pounds per square inch is— | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1,000,000 | | 1,100,000 | | 1,200,000 | | 1,400,000 | | 1,600,000 | | 200 | | 300 | | 400 | | 500 | | 600 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 7 | 10 | 8 | 1 | 8 | 4 | 8 | 9 | 9 | 2 | 4 | 0 | 4 | 10 | 5 | 8 | 6 | 3 | 6 | 11 |
| | 16 | 7 | 1 | 7 | 4 | 7 | 7 | 7 | 11 | 8 | 4 | 3 | 5 | 4 | 3 | 4 | 10 | 5 | 5 | 6 | 0 |
| | 24 | 6 | 2 | 6 | 5 | 6 | 7 | 6 | 11 | 7 | 3 | 2 | 10 | 3 | 5 | 4 | 0 | 4 | 5 | 4 | 10 |
| 2×6 | 12 | 12 | 2 | 12 | 6 | 12 | 11 | 13 | 7 | 14 | 2 | 6 | 2 | 7 | 7 | 8 | 9 | 9 | 9 | 10 | 8 |
| | 16 | 11 | 0 | 11 | 5 | 11 | 9 | 12 | 4 | 12 | 11 | 5 | 4 | 6 | 7 | 7 | 7 | 8 | 5 | 9 | 3 |
| | 24 | 9 | 8 | 9 | 11 | 10 | 3 | 10 | 9 | 11 | 3 | 4 | 4 | 5 | 4 | 6 | 2 | 6 | 11 | 7 | 7 |
| 2×8 | 12 | 16 | 2 | 16 | 8 | 17 | 2 | 18 | 1 | 18 | 11 | 8 | 3 | 10 | 1 | 11 | 8 | 13 | 0 | 14 | 3 |
| | 16 | 14 | 8 | 15 | 2 | 15 | 7 | 16 | 5 | 17 | 2 | 7 | 2 | 8 | 9 | 10 | 1 | 11 | 3 | 12 | 4 |
| | 24 | 12 | 10 | 13 | 3 | 13 | 8 | 14 | 4 | 15 | 0 | 5 | 10 | 7 | 2 | 8 | 3 | 9 | 2 | 10 | 1 |
| 2×10 | 12 | 20 | 6 | 21 | 2 | 21 | 9 | 22 | 11 | 24 | 0 | 10 | 5 | 12 | 9 | 14 | 9 | 16 | 6 | 18 | 1 |
| | 16 | 18 | 7 | 19 | 3 | 19 | 9 | 20 | 10 | 21 | 9 | 9 | 0 | 11 | 1 | 12 | 9 | 14 | 3 | 15 | 8 |
| | 24 | 16 | 3 | 16 | 9 | 17 | 3 | 18 | 2 | 19 | 0 | 7 | 4 | 9 | 0 | 10 | 5 | 11 | 8 | 12 | 9 |
| 2×12 | 12 | 24 | 10 | 25 | 7 | 26 | 4 | 27 | 9 | 29 | 0 | 12 | 7 | 15 | 5 | 17 | 10 | 19 | 11 | 21 | 10 |
| | 16 | 22 | 6 | 23 | 3 | 23 | 11 | 25 | 2 | 26 | 4 | 10 | 11 | 13 | 5 | 15 | 5 | 17 | 3 | 18 | 11 |
| | 24 | 19 | 8 | 20 | 4 | 20 | 11 | 22 | 0 | 23 | 0 | 8 | 11 | 10 | 11 | 12 | 7 | 14 | 1 | 15 | 5 |

[1] This table is based on FHA design recommendations as follows:
(a) When fiber stress is the controlling factor, the assumed total design load is 30 lb/ft², comprised of 20 lb/ft² superimposed load and 10 lb/ft² dead load.
(b) When deflection is the controlling factor, the deflection limitation of 1/360 of the span is based on an assumed total load of 20 lb/ft².
[2] Maximum spans for working stresses which are between those tabulated shall be determined by interpolation.

*spans [1] for ceiling joists*

load (no storage)]

Span [2] determined by bending when fiber stress in pounds per square inch is—Continued

| 700 | | 800 | | 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 12 | 11 | 13 | 9 | 14 | 7 | 15 | 5 | 16 | 2 | 16 | 11 | 17 | 7 | 18 | 3 | 18 | 10 | 19 | 6 | 20 | 1 | 20 | 8 |
| 11 | 2 | 11 | 11 | 12 | 8 | 13 | 4 | 14 | 0 | 14 | 7 | 15 | 3 | 15 | 9 | 16 | 4 | 16 | 11 | 17 | 5 | 17 | 9 |
| 9 | 2 | 9 | 9 | 10 | 4 | 10 | 11 | 11 | 5 | 11 | 11 | 12 | 5 | 12 | 11 | 13 | 4 | 13 | 9 | 14 | 2 | 14 | 7 |
| 20 | 0 | 21 | 5 | 22 | 8 | 23 | 11 | 25 | 1 | 26 | 2 | 27 | 3 | 28 | 3 | 29 | 3 | 30 | 3 | 31 | 2 | 32 | 1 |
| 17 | 4 | 18 | 6 | 19 | 8 | 20 | 8 | 21 | 9 | 22 | 8 | 23 | 7 | 24 | 6 | 25 | 4 | 26 | 2 | 27 | 0 | 27 | 9 |
| 14 | 2 | 15 | 1 | 16 | 0 | 16 | 11 | 17 | 9 | 18 | 6 | 19 | 3 | 20 | 0 | 20 | 8 | 21 | 5 | 22 | 0 | 22 | 8 |
| 26 | 8 | 28 | 6 | 30 | 3 | 31 | 10 | 33 | 5 | 34 | 11 | 36 | 4 | 37 | 8 | 39 | 0 | 40 | 4 | 41 | 7 | 42 | 9 |
| 23 | 1 | 24 | 8 | 26 | 2 | 27 | 7 | 28 | 11 | 30 | 3 | 31 | 6 | 32 | 8 | 33 | 10 | 34 | 11 | 36 | 0 | 37 | 0 |
| 18 | 10 | 20 | 2 | 21 | 5 | 22 | 6 | 23 | 8 | 24 | 8 | 25 | 8 | 26 | 8 | 27 | 7 | 28 | 6 | 29 | 5 | 30 | 3 |
| 33 | 9 | 36 | 1 | 38 | 4 | 40 | 4 | 42 | 4 | 44 | 3 | 46 | 0 | 47 | 9 | 49 | 5 | 51 | 5 | 52 | 8 | 54 | 2 |
| 29 | 3 | 31 | 3 | 33 | 2 | 34 | 11 | 36 | 8 | 38 | 4 | 39 | 10 | 41 | 4 | 42 | 10 | 44 | 3 | 45 | 7 | 46 | 11 |
| 23 | 11 | 25 | 6 | 27 | 1 | 28 | 7 | 29 | 11 | 31 | 3 | 32 | 7 | 33 | 9 | 34 | 11 | 36 | 1 | 37 | 3 | 38 | 4 |
| 40 | 11 | 43 | 8 | 46 | 4 | 48 | 10 | 51 | 3 | 53 | 6 | 55 | 9 | 57 | 10 | 59 | 10 | 61 | 10 | 63 | 9 | 65 | 7 |
| 35 | 5 | 37 | 11 | 40 | 2 | 42 | 4 | 44 | 5 | 46 | 4 | 48 | 3 | 50 | 1 | 51 | 10 | 53 | 6 | 55 | 2 | 56 | 9 |
| 28 | 11 | 30 | 11 | 32 | 9 | 34 | 7 | 36 | 3 | 37 | 10 | 39 | 5 | 40 | 11 | 42 | 4 | 43 | 8 | 45 | 1 | 46 | 4 |

U. S. Department of Agriculture, Forest Service,
Forest Products Laboratory,
*Madison, Wis., September 29, 1941;*
*revised December 15, 1941.*

*for ceiling joists*

load (light storage)]

Span [2] determined by bending when fiber stress in pounds per square inch is—Continued

| 700 | | 800 | | 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 7 | 5 | 7 | 11 | 8 | 5 | 8 | 11 | 9 | 4 | 9 | 9 | 10 | 2 | 10 | 6 | 10 | 11 | 11 | 3 | 11 | 7 | 11 | 11 |
| 6 | 5 | 6 | 11 | 7 | 4 | 7 | 8 | 8 | 1 | 8 | 5 | 8 | 9 | 9 | 1 | 9 | 5 | 9 | 9 | 10 | 1 | 10 | 4 |
| 5 | 3 | 5 | 8 | 6 | 0 | 6 | 3 | 6 | 7 | 6 | 11 | 7 | 2 | 7 | 5 | 7 | 8 | 7 | 11 | 8 | 2 | 8 | 5 |
| 11 | 7 | 12 | 4 | 13 | 1 | 13 | 10 | 14 | 6 | 15 | 1 | 15 | 9 | 16 | 4 | 16 | 11 | 17 | 5 | 18 | 0 | 18 | 6 |
| 10 | 0 | 10 | 8 | 11 | 4 | 11 | 11 | 12 | 6 | 13 | 1 | 13 | 8 | 14 | 2 | 14 | 8 | 15 | 1 | 15 | 7 | 16 | 0 |
| 8 | 2 | 8 | 9 | 9 | 3 | 9 | 9 | 10 | 3 | 10 | 8 | 11 | 2 | 11 | 7 | 11 | 11 | 12 | 4 | 12 | 9 | 13 | 1 |
| 15 | 5 | 16 | 5 | 17 | 5 | 18 | 5 | 19 | 4 | 20 | 2 | 21 | 0 | 21 | 9 | 22 | 6 | 23 | 3 | 24 | 0 | 24 | 8 |
| 13 | 4 | 14 | 3 | 15 | 1 | 15 | 11 | 16 | 9 | 17 | 5 | 18 | 2 | 18 | 10 | 19 | 6 | 20 | 2 | 20 | 9 | 21 | 5 |
| 10 | 11 | 11 | 8 | 12 | 4 | 13 | 0 | 13 | 8 | 14 | 3 | 14 | 10 | 15 | 5 | 15 | 11 | 16 | 5 | 17 | 0 | 17 | 5 |
| 19 | 6 | 20 | 10 | 22 | 1 | 23 | 4 | 24 | 5 | 25 | 6 | 26 | 7 | 27 | 7 | 28 | 7 | 29 | 6 | 30 | 5 | 31 | 3 |
| 16 | 11 | 18 | 1 | 19 | 2 | 20 | 2 | 21 | 2 | 22 | 1 | 23 | 0 | 23 | 11 | 24 | 9 | 25 | 6 | 26 | 4 | 27 | 1 |
| 13 | 9 | 14 | 9 | 15 | 8 | 16 | 6 | 17 | 3 | 18 | 1 | 18 | 9 | 19 | 6 | 20 | 2 | 20 | 10 | 21 | 6 | 22 | 1 |
| 23 | 7 | 25 | 3 | 26 | 9 | 28 | 3 | 29 | 7 | 30 | 11 | 32 | 2 | 33 | 5 | 34 | 7 | 35 | 8 | 36 | 9 | 37 | 10 |
| 20 | 5 | 21 | 10 | 23 | 2 | 24 | 5 | 25 | 8 | 26 | 9 | 27 | 10 | 28 | 11 | 29 | 11 | 30 | 11 | 31 | 10 | 32 | 9 |
| 16 | 8 | 17 | 10 | 18 | 11 | 19 | 11 | 20 | 11 | 21 | 10 | 22 | 9 | 23 | 7 | 24 | 5 | 25 | 3 | 26 | 0 | 26 | 9 |

U. S. Department of Agriculture, Forest Service,
Forest Products Laboratory,
*Madison, Wis., September 29, 1941;*
*revised December 15, 1941.*

TABLE 8.—*Maximum spans* [1] *for roof joists and rafters for*

[For localities where maximum

| Size (nominal) | Spacing | Span [2] determined by bending when fiber stress in pounds per square inch is— | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | | 300 | | 400 | | 500 | | 600 | | 700 | | 800 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 4 | 0 | 4 | 10 | 5 | 8 | 6 | 4 | 6 | 11 | 7 | 5 | 7 | 11 |
| | 16 | 3 | 5 | 4 | 3 | 4 | 10 | 5 | 5 | 6 | 0 | 6 | 5 | 6 | 11 |
| | 24 | 2 | 10 | 3 | 5 | 4 | 0 | 4 | 6 | 4 | 10 | 5 | 3 | 5 | 8 |
| 2×6 | 12 | 6 | 2 | 7 | 7 | 8 | 9 | 9 | 9 | 10 | 8 | 11 | 7 | 12 | 4 |
| | 16 | 5 | 4 | 6 | 7 | 7 | 7 | 8 | 5 | 9 | 3 | 10 | 0 | 10 | 8 |
| | 24 | 4 | 4 | 5 | 4 | 6 | 2 | 6 | 11 | 7 | 7 | 8 | 2 | 8 | 9 |
| 2×8 | 12 | 8 | 3 | 10 | 1 | 11 | 8 | 13 | 0 | 14 | 3 | 15 | 5 | 16 | 5 |
| | 16 | 7 | 2 | 8 | 9 | 10 | 1 | 11 | 4 | 12 | 4 | 13 | 4 | 14 | 3 |
| | 24 | 5 | 10 | 7 | 2 | 8 | 3 | 9 | 3 | 10 | 1 | 10 | 11 | 11 | 8 |
| 2×10 | 12 | 10 | 5 | 12 | 9 | 14 | 9 | 16 | 6 | 18 | 1 | 19 | 6 | 20 | 10 |
| | 16 | 9 | 0 | 11 | 1 | 12 | 9 | 14 | 4 | 15 | 8 | 16 | 11 | 18 | 1 |
| | 24 | 7 | 4 | 9 | 1 | 10 | 5 | 11 | 8 | 12 | 9 | 13 | 9 | 14 | 9 |

[1] This table is based on FHA design recommendations as follows:
(a) The total assumed design load is 30 lb/ft², composed of 20 lb/ft² live load and 10 lb/ft² dead load.
(b) All loads are considered to be acting vertically.
(c) Span is the horizontal projection of the rafter between supports.
[2] Maximum spans for fiber stresses which are between those tabulated shall be determined by interpolation.

TABLE 8a.—*Maximum spans* [1] *for roof joists and rafters*

[For localities where maximum

| Size (nominal) | Spacing | Span [2] determined by bending when fiber stress in pounds per square inch is— | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | | 300 | | 400 | | 500 | | 600 | | 700 | | 800 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 3 | 5 | 4 | 3 | 4 | 11 | 5 | 5 | 6 | 0 | 6 | 5 | 6 | 11 |
| | 16 | 3 | 0 | 3 | 8 | 4 | 3 | 4 | 9 | 5 | 2 | 5 | 7 | 6 | 0 |
| | 24 | 2 | 6 | 3 | 0 | 3 | 5 | 3 | 11 | 4 | 3 | 4 | 7 | 4 | 10 |
| 2×6 | 12 | 5 | 4 | 6 | 7 | 7 | 7 | 8 | 6 | 9 | 3 | 10 | 0 | 10 | 8 |
| | 16 | 4 | 8 | 5 | 8 | 6 | 7 | 7 | 4 | 8 | 1 | 8 | 8 | 9 | 3 |
| | 24 | 3 | 10 | 4 | 8 | 5 | 4 | 6 | 0 | 6 | 7 | 7 | 1 | 7 | 7 |
| 2×8 | 12 | 7 | 2 | 8 | 9 | 10 | 1 | 11 | 3 | 12 | 4 | 13 | 4 | 14 | 3 |
| | 16 | 6 | 3 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 9 | 11 | 7 | 12 | 4 |
| | 24 | 5 | 1 | 6 | 2 | 7 | 2 | 8 | 0 | 8 | 9 | 9 | 5 | 10 | 1 |
| 2×10 | 12 | 9 | 0 | 11 | 1 | 12 | 9 | 14 | 4 | 15 | 8 | 16 | 11 | 18 | 1 |
| | 16 | 7 | 10 | 9 | 8 | 11 | 1 | 12 | 5 | 13 | 7 | 14 | 7 | 15 | 8 |
| | 24 | 6 | 4 | 7 | 10 | 9 | 0 | 10 | 1 | 11 | 1 | 11 | 11 | 12 | 9 |

[1] This table is based on FHA design recommendations as follows:
(a) The total assumed design load is 40 lb/ft², composed of 30 lb/ft² live load and 10 lb/ft² dead load.
(b) All loads are considered to be acting vertically.
(c) Span is the horizontal projection of the rafter between supports.
[2] Maximum spans for fiber stresses which are between those tabulated shall be determined by interpolation.

*slopes of 3 in 12 and less, not supporting plastered ceiling*

live load is 20 lb/ft²]

Span [2] determined by bending when fiber stress in pounds per square inch is—Continued

| 900 | 1,000 | 1,100 | 1,200 | 1,300 | 1,400 | 1,500 | 1,600 | 1,700 | 1,800 |
|---|---|---|---|---|---|---|---|---|---|
| ft in. | ft in. | ft in. | ft in. | ft in. | ft in. | ft in. | ft in. | ft in. | ft in. |
| 8 5 | 8 11 | 9 4 | 9 9 | 10 2 | 10 6 | 10 11 | 11 3 | 11 7 | 11 11 |
| 7 4 | 7 8 | 8 1 | 8 5 | 8 9 | 9 1 | 9 5 | 9 9 | 10 1 | 10 4 |
| 6 0 | 6 3 | 6 7 | 6 11 | 7 2 | 7 5 | 7 8 | 7 11 | 8 2 | 8 5 |
| 13 1 | 13 10 | 14 6 | 15 1 | 15 9 | 16 4 | 16 11 | 17 5 | 18 0 | 18 6 |
| 11 4 | 11 11 | 12 6 | 13 1 | 13 8 | 14 2 | 14 8 | 15 1 | 15 7 | 16 0 |
| 9 3 | 9 9 | 10 3 | 10 8 | 11 2 | 11 7 | 11 11 | 12 4 | 12 9 | 13 1 |
| 17 5 | 18 5 | 19 4 | 20 2 | 21 0 | 21 9 | 22 6 | 23 3 | 24 0 | 24 8 |
| 15 1 | 15 11 | 16 9 | 17 5 | 18 2 | 18 10 | 19 6 | 20 2 | 20 9 | 21 5 |
| 12 4 | 13 0 | 13 8 | 14 3 | 14 10 | 15 5 | 15 11 | 16 5 | 17 0 | 17 5 |
| 22 1 | 23 4 | 24 5 | 25 6 | 26 7 | 27 7 | 28 7 | 29 6 | 30 5 | 31 3 |
| 19 2 | 20 2 | 21 2 | 22 1 | 23 0 | 23 11 | 24 9 | 25 6 | 26 4 | 27 1 |
| 15 8 | 16 6 | 17 3 | 18 1 | 18 9 | 19 6 | 20 2 | 20 10 | 21 6 | 22 1 |

*for slopes of 3 in 12 and less, not supporting plastered ceiling*

live load is 30 lb/ft²]

Span [2] determined by bending when fiber stress in pounds per square inch is—Continued

| 900 | 1,000 | 1,100 | 1,200 | 1,300 | 1,400 | 1,500 | 1,600 | 1,700 | 1,800 |
|---|---|---|---|---|---|---|---|---|---|
| ft in. | ft in. | ft in. | ft in. | ft in. | ft in. | ft in. | ft in. | ft in. | ft in. |
| 7 4 | 7 8 | 8 1 | 8 5 | 8 9 | 9 1 | 9 5 | 9 9 | 10 1 | 10 4 |
| 6 4 | 6 8 | 7 0 | 7 4 | 7 7 | 7 11 | 8 2 | 8 5 | 8 8 | 8 11 |
| 5 2 | 5 5 | 5 9 | 6 0 | 6 3 | 6 5 | 6 8 | 6 11 | 7 1 | 7 4 |
| 11 4 | 11 11 | 12 6 | 13 1 | 13 8 | 14 2 | 14 8 | 15 1 | 15 7 | 16 0 |
| 9 10 | 10 4 | 10 10 | 11 4 | 11 10 | 12 3 | 12 8 | 13 1 | 13 6 | 13 11 |
| 8 0 | 8 5 | 8 10 | 9 3 | 9 8 | 10 0 | 10 4 | 10 8 | 11 0 | 11 4 |
| 15 1 | 15 11 | 16 9 | 17 5 | 18 2 | 18 10 | 19 6 | 20 2 | 20 9 | 21 5 |
| 13 1 | 13 10 | 14 6 | 15 1 | 15 9 | 16 4 | 16 11 | 17 5 | 18 0 | 18 6 |
| 10 8 | 11 3 | 11 10 | 12 4 | 12 10 | 13 4 | 13 10 | 14 3 | 14 8 | 15 1 |
| 19 2 | 20 2 | 21 2 | 22 1 | 23 0 | 23 11 | 24 9 | 25 6 | 26 4 | 27 1 |
| 16 7 | 17 6 | 18 4 | 19 2 | 19 11 | 20 8 | 21 5 | 22 1 | 22 9 | 23 5 |
| 13 6 | 14 3 | 15 0 | 15 8 | 16 3 | 16 11 | 17 6 | 18 1 | 18 7 | 19 2 |

TABLE 9.—*Maximum spans* [1] *for roof joists and rafters*

[For localities where maximum

| Size (nominal) | Spacing | Span limited by deflection when modulus of elasticity in pounds per square inch is— | | | | | | | | | | Span [2] determined by bending when fiber stress in pounds per square inch is— | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1,000,000 | | 1,100,000 | | 1,200,000 | | 1,400,000 | | 1,600,000 | | 200 | | 300 | | 400 | | 500 | | 600 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 7 | 10 | 8 | 1 | 8 | 4 | 8 | 9 | 9 | 2 | 3 | 5 | 4 | 3 | 4 | 11 | 5 | 5 | 6 | 0 |
| | 16 | 7 | 1 | 7 | 4 | 7 | 7 | 7 | 11 | 8 | 4 | 3 | 0 | 3 | 8 | 4 | 3 | 4 | 9 | 5 | 2 |
| | 24 | 6 | 2 | 6 | 5 | 6 | 7 | 6 | 11 | 7 | 3 | 2 | 6 | 3 | 0 | 3 | 5 | 3 | 11 | 4 | 3 |
| 2×6 | 12 | 12 | 2 | 12 | 6 | 12 | 11 | 13 | 7 | 14 | 2 | 5 | 4 | 6 | 7 | 7 | 7 | 8 | 6 | 9 | 3 |
| | 16 | 11 | 0 | 11 | 5 | 11 | 9 | 12 | 4 | 12 | 11 | 4 | 8 | 5 | 8 | 6 | 7 | 7 | 4 | 8 | 1 |
| | 24 | 9 | 8 | 9 | 11 | 10 | 3 | 10 | 9 | 11 | 3 | 3 | 10 | 4 | 8 | 5 | 4 | 6 | 0 | 6 | 7 |
| 2×8 | 12 | 16 | 2 | 16 | 8 | 17 | 2 | 18 | 1 | 18 | 11 | 7 | 2 | 8 | 9 | 10 | 1 | 11 | 3 | 12 | 4 |
| | 16 | 14 | 8 | 15 | 2 | 15 | 7 | 16 | 5 | 17 | 2 | 6 | 3 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 9 |
| | 24 | 12 | 10 | 13 | 3 | 13 | 8 | 14 | 4 | 15 | 0 | 5 | 1 | 6 | 2 | 7 | 2 | 8 | 0 | 8 | 9 |
| 2×10 | 12 | 20 | 6 | 21 | 2 | 21 | 9 | 22 | 11 | 24 | 0 | 9 | 0 | 11 | 1 | 12 | 9 | 14 | 4 | 15 | 8 |
| | 16 | 18 | 7 | 19 | 3 | 19 | 9 | 20 | 10 | 21 | 9 | 7 | 10 | 9 | 8 | 11 | 1 | 12 | 5 | 13 | 7 |
| | 24 | 16 | 3 | 16 | 9 | 17 | 3 | 18 | 2 | 19 | 0 | 6 | 4 | 7 | 10 | 9 | 0 | 10 | 1 | 11 | 1 |

[1] This table is based on FHA design recommendations as follows:
(a) When fiber stress is the controlling factor, the assumed total design load is 40 lb/ft², composed of 20 lb/ft² live load and 20 lb/ft² dead load.
(b) When deflection is the controlling factor, i. e., when joists or rafters support a finished ceiling, the deflection limitation of 1/360 of the span is based on an assumed total load of 20 lb/ft².
(c) All loads are considered to be acting vertically.
(d) Span is the horizontal projection of the rafter between supports.

[2] Maximum spans for fiber stresses which are between those tabulated shall be determined by interpolation.

TABLE 9a.—*Maximum spans* [1] *for roof joists and rafters*

[For localities where maximum

| Size (nominal) | Spacing | Span limited by deflection when modulus of elasticity in pounds per square inch is— | | | | | | | | | | Span [2] determined by bending when fiber stress in pounds per square inch is— | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1,000,000 | | 1,100,000 | | 1,200,000 | | 1,400,000 | | 1,600,000 | | 200 | | 300 | | 400 | | 500 | | 600 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 6 | 10 | 7 | 1 | 7 | 3 | 7 | 8 | 8 | 0 | 3 | 1 | 3 | 9 | 4 | 4 | 4 | 11 | 5 | 4 |
| | 16 | 6 | 2 | 6 | 5 | 6 | 7 | 6 | 11 | 7 | 3 | 2 | 8 | 3 | 3 | 3 | 9 | 4 | 3 | 4 | 8 |
| | 24 | 5 | 4 | 5 | 6 | 5 | 9 | 6 | 1 | 6 | 4 | 2 | 2 | 2 | 8 | 3 | 1 | 3 | 5 | 3 | 9 |
| 2×6 | 12 | 10 | 7 | 10 | 11 | 11 | 3 | 11 | 10 | 12 | 5 | 4 | 9 | 5 | 10 | 6 | 9 | 7 | 7 | 8 | 3 |
| | 16 | 9 | 8 | 9 | 11 | 10 | 3 | 10 | 9 | 11 | 3 | 4 | 2 | 5 | 1 | 5 | 10 | 6 | 7 | 7 | 2 |
| | 24 | 8 | 5 | 8 | 8 | 8 | 11 | 9 | 5 | 9 | 10 | 3 | 4 | 4 | 2 | 4 | 9 | 5 | 4 | 5 | 10 |
| 2×8 | 12 | 14 | 2 | 14 | 7 | 15 | 0 | 15 | 10 | 16 | 6 | 6 | 4 | 7 | 10 | 9 | 0 | 10 | 1 | 11 | 0 |
| | 16 | 12 | 10 | 13 | 3 | 13 | 8 | 14 | 4 | 15 | 0 | 5 | 7 | 6 | 9 | 7 | 10 | 8 | 9 | 9 | 7 |
| | 24 | 11 | 3 | 11 | 7 | 11 | 11 | 12 | 7 | 13 | 1 | 4 | 6 | 5 | 6 | 6 | 5 | 7 | 2 | 7 | 10 |
| 2×10 | 12 | 17 | 11 | 18 | 6 | 19 | 0 | 20 | 0 | 20 | 11 | 8 | 1 | 9 | 11 | 11 | 5 | 12 | 9 | 14 | 0 |
| | 16 | 16 | 3 | 16 | 9 | 17 | 3 | 18 | 2 | 19 | 0 | 7 | 0 | 8 | 7 | 9 | 11 | 11 | 1 | 12 | 1 |
| | 24 | 14 | 2 | 14 | 8 | 15 | 1 | 15 | 11 | 16 | 7 | 5 | 9 | 7 | 0 | 8 | 1 | 9 | 0 | 9 | 11 |

[1] This table is based on FHA design recommendations as follows:
(a) When fiber stress is the controlling factor, the assumed total design load is 50 lb/ft², composed of 30 lb/ft² live load and 20 lb/ft² dead load.
(b) When deflection is the controlling factor, i. e., when joists or rafters support a finished ceiling, the deflection limitation of 1/360 of the span is based on an assumed total load of 30 lb/ft².
(c) All loads are considered to be acting vertically.
(d) Span is the horizontal projection of the rafter between supports.

[2] Maximum spans for fiber stresses which are between those tabulated shall be determined by interpolation.

*for slopes of 3 in 12 and less, supporting plastered ceiling*

live load is 20 lb/ft²]

| Span [2] determined by bending when fiber stress in pounds per square inch is—Continued | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | | 800 | | 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 6 | 5 | 6 | 11 | 7 | 4 | 7 | 8 | 8 | 1 | 8 | 5 | 8 | 9 | 9 | 1 | 9 | 5 | 9 | 9 | 10 | 1 | 10 | 4 |
| 5 | 7 | 6 | 0 | 6 | 4 | 6 | 8 | 7 | 0 | 7 | 4 | 7 | 7 | 7 | 11 | 8 | 2 | 8 | 5 | 8 | 8 | 8 | 11 |
| 4 | 7 | 4 | 10 | 5 | 2 | 5 | 5 | 5 | 9 | 6 | 0 | 6 | 3 | 6 | 5 | 6 | 8 | 6 | 11 | 7 | 1 | 7 | 4 |
| 10 | 0 | 10 | 8 | 11 | 4 | 11 | 11 | 12 | 6 | 13 | 1 | 13 | 8 | 14 | 2 | 14 | 8 | 15 | 1 | 15 | 7 | 16 | 0 |
| 8 | 8 | 9 | 3 | 9 | 10 | 10 | 4 | 10 | 10 | 11 | 4 | 11 | 10 | 12 | 3 | 12 | 8 | 13 | 1 | 13 | 6 | 13 | 11 |
| 7 | 1 | 7 | 7 | 8 | 0 | 8 | 5 | 8 | 10 | 9 | 3 | 9 | 8 | 10 | 0 | 10 | 4 | 10 | 8 | 11 | 0 | 11 | 4 |
| 13 | 4 | 14 | 3 | 15 | 1 | 15 | 11 | 16 | 9 | 17 | 5 | 18 | 2 | 18 | 10 | 19 | 6 | 20 | 2 | 20 | 9 | 21 | 5 |
| 11 | 7 | 12 | 4 | 13 | 1 | 13 | 10 | 14 | 6 | 15 | 1 | 15 | 9 | 16 | 4 | 16 | 11 | 17 | 5 | 18 | 0 | 18 | 6 |
| 9 | 5 | 10 | 1 | 10 | 8 | 11 | 3 | 11 | 10 | 12 | 4 | 12 | 10 | 13 | 4 | 13 | 10 | 14 | 3 | 14 | 8 | 15 | 1 |
| 16 | 11 | 18 | 1 | 19 | 2 | 20 | 2 | 21 | 2 | 22 | 1 | 23 | 0 | 23 | 11 | 24 | 9 | 25 | 6 | 26 | 4 | 27 | 1 |
| 14 | 7 | 15 | 8 | 16 | 7 | 17 | 6 | 18 | 4 | 19 | 2 | 19 | 11 | 20 | 8 | 21 | 5 | 22 | 1 | 22 | 9 | 23 | 5 |
| 11 | 11 | 12 | 9 | 13 | 6 | 14 | 3 | 15 | 0 | 15 | 8 | 16 | 3 | 16 | 11 | 17 | 6 | 18 | 1 | 18 | 7 | 19 | 2 |

*for slopes of 3 in 12 and less, supporting plastered ceiling*

live load is 30 lb/ft²]

| Span [2] determined by bending when fiber stress in pounds per square inch is—Continued | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | | 800 | | 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 5 | 9 | 6 | 2 | 6 | 7 | 6 | 11 | 7 | 3 | 7 | 7 | 7 | 10 | 8 | 2 | 8 | 6 | 8 | 9 | 9 | 0 | 9 | 3 |
| 5 | 0 | 5 | 4 | 5 | 8 | 6 | 0 | 6 | 3 | 6 | 7 | 6 | 10 | 7 | 1 | 7 | 4 | 7 | 7 | 7 | 10 | 8 | 0 |
| 4 | 1 | 4 | 4 | 4 | 8 | 4 | 10 | 5 | 2 | 5 | 4 | 5 | 7 | 5 | 9 | 6 | 0 | 6 | 2 | 6 | 4 | 6 | 7 |
| 9 | 0 | 9 | 7 | 10 | 2 | 10 | 8 | 11 | 3 | 11 | 9 | 12 | 2 | 12 | 8 | 13 | 1 | 13 | 6 | 13 | 11 | 14 | 4 |
| 7 | 9 | 8 | 3 | 8 | 9 | 9 | 3 | 9 | 9 | 10 | 2 | 10 | 7 | 11 | 0 | 11 | 4 | 11 | 9 | 12 | 1 | 12 | 5 |
| 6 | 4 | 6 | 9 | 7 | 2 | 7 | 7 | 7 | 11 | 8 | 3 | 8 | 8 | 8 | 11 | 9 | 3 | 9 | 7 | 9 | 10 | 10 | 2 |
| 11 | 11 | 12 | 9 | 13 | 6 | 14 | 3 | 14 | 11 | 15 | 8 | 16 | 3 | 16 | 11 | 17 | 6 | 18 | 0 | 18 | 7 | 19 | 2 |
| 10 | 4 | 11 | 1 | 11 | 9 | 12 | 4 | 13 | 0 | 13 | 6 | 14 | 1 | 14 | 8 | 15 | 2 | 15 | 8 | 16 | 2 | 16 | 7 |
| 8 | 6 | 9 | 0 | 9 | 7 | 10 | 1 | 10 | 7 | 11 | 1 | 11 | 6 | 11 | 11 | 12 | 4 | 12 | 9 | 13 | 2 | 13 | 6 |
| 15 | 1 | 16 | 2 | 17 | 1 | 18 | 0 | 18 | 11 | 19 | 10 | 20 | 7 | 21 | 4 | 22 | 1 | 22 | 10 | 23 | 6 | 24 | 2 |
| 13 | 1 | 14 | 0 | 14 | 10 | 15 | 8 | 16 | 5 | 17 | 1 | 17 | 10 | 18 | 6 | 19 | 2 | 19 | 10 | 20 | 5 | 21 | 0 |
| 10 | 8 | 11 | 5 | 12 | 1 | 12 | 9 | 13 | 5 | 14 | 0 | 14 | 7 | 15 | 1 | 15 | 8 | 16 | 2 | 16 | 8 | 17 | 2 |

TABLE 10.—*Maximum spans* [1] *for roof rafters for slopes*

[For localities where maximum

| Size (nominal) | Spacing | Span [3] determined by bending when working stress in pounds per square inch is— | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | | 300 | | 400 | | 500 | | 600 | | 700 | | 800 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 4 | 1 | 5 | 0 | 5 | 10 | 6 | 6 | 7 | 1 | 7 | 9 | 8 | 3 |
| | 16 | 3 | 7 | 4 | 5 | 5 | 1 | 5 | 8 | 6 | 2 | 6 | 9 | 7 | 2 |
| | 24 | 2 | 11 | 3 | 7 | 4 | 1 | 4 | 7 | 5 | 0 | 5 | 5 | 5 | 10 |
| 2×6 | 12 | 6 | 4 | 7 | 10 | 9 | 0 | 10 | 1 | 11 | 0 | 12 | 0 | 12 | 9 |
| | 16 | 5 | 7 | 6 | 10 | 7 | 10 | 8 | 9 | 9 | 7 | 10 | 5 | 11 | 1 |
| | 24 | 4 | 6 | 5 | 7 | 6 | 5 | 7 | 2 | 7 | 10 | 8 | 5 | 9 | 0 |
| 2×8 | 12 | 8 | 6 | 10 | 5 | 12 | 1 | 13 | 6 | 14 | 9 | 16 | 0 | 17 | 0 |
| | 16 | 7 | 5 | 9 | 1 | 10 | 6 | 11 | 9 | 12 | 11 | 13 | 11 | 14 | 10 |
| | 24 | 6 | 1 | 7 | 4 | 8 | 6 | 9 | 6 | 10 | 5 | 11 | 3 | 12 | 1 |
| 2×10 | 12 | 10 | 10 | 13 | 3 | 15 | 3 | 17 | 1 | 18 | 8 | 20 | 3 | 21 | 8 |
| | 16 | 9 | 5 | 11 | 6 | 13 | 4 | 14 | 10 | 16 | 3 | 17 | 7 | 18 | 9 |
| | 24 | 7 | 8 | 9 | 4 | 10 | 10 | 12 | 1 | 13 | 3 | 14 | 4 | 15 | 3 |

[1] This table is based upon FHA design recommendations as follows:
(a) Total load=28 lb/ft² acting vertically.
(b) Span is the horizontal projection of the rafter between supports.
[2] Weight of roofing material and roof construction=7 lb/ft².
[3] Maximum spans for working stresses which are between those tabulated shall be determined by interpolation.

TABLE 10a.—*Maximum spans* [1] *for roof rafters for slopes*

[For localities where maximum

| Size (nominal) | Spacing | Span [3] determined by bending when fiber stress in pounds per square inch is— | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | | 300 | | 400 | | 500 | | 600 | | 700 | | 800 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 3 | 9 | 4 | 7 | 5 | 4 | 5 | 11 | 6 | 6 | 7 | 0 | 7 | 6 |
| | 16 | 3 | 3 | 4 | 0 | 4 | 7 | 5 | 1 | 5 | 8 | 6 | 1 | 6 | 6 |
| | 24 | 2 | 8 | 3 | 3 | 3 | 9 | 4 | 2 | 4 | 7 | 4 | 11 | 5 | 3 |
| 2×6 | 12 | 5 | 10 | 7 | 1 | 8 | 2 | 9 | 2 | 10 | 0 | 10 | 10 | 11 | 7 |
| | 16 | 5 | 0 | 6 | 2 | 7 | 1 | 7 | 11 | 8 | 8 | 9 | 5 | 10 | 0 |
| | 24 | 4 | 1 | 5 | 0 | 5 | 10 | 6 | 6 | 7 | 1 | 7 | 8 | 8 | 2 |
| 2×8 | 12 | 7 | 9 | 9 | 5 | 10 | 11 | 12 | 3 | 13 | 5 | 14 | 6 | 15 | 6 |
| | 16 | 6 | 9 | 8 | 3 | 9 | 6 | 10 | 7 | 11 | 8 | 12 | 8 | 13 | 6 |
| | 24 | 5 | 5 | 6 | 9 | 7 | 9 | 8 | 8 | 9 | 5 | 10 | 3 | 10 | 11 |
| 2×10 | 12 | 9 | 10 | 12 | 0 | 13 | 10 | 15 | 6 | 17 | 0 | 18 | 4 | 19 | 7 |
| | 16 | 8 | 7 | 10 | 5 | 12 | 1 | 13 | 5 | 14 | 9 | 16 | 0 | 17 | 1 |
| | 24 | 6 | 11 | 8 | 6 | 9 | 10 | 10 | 11 | 12 | 0 | 13 | 0 | 13 | 10 |

[1] This table is based upon FHA design recommendations as follows:
(a) Total load=34 lb/ft² acting vertically.
(b) Span is the horizontal projection of the rafter between supports.
[2] Weight of roofing material and roof construction=7 lb/ft².
[3] Maximum spans for working stresses which are between those tabulated shall be determined by interpolation.

*between 8½ in 12 and 3 in 12, light roofing material* [2]

live load is 20 lb/ft²]

| Span [3] determined by bending when working stress in pounds per square inch is—Continued | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 8 | 9 | 9 | 3 | 9 | 8 | 10 | 1 | 10 | 6 | 10 | 11 | 11 | 4 | 11 | 8 | 12 | 0 | 12 | 4 |
| 7 | 7 | 8 | 0 | 8 | 5 | 8 | 9 | 9 | 1 | 9 | 6 | 9 | 10 | 10 | 1 | 10 | 5 | 10 | 9 |
| 6 | 2 | 6 | 6 | 6 | 10 | 7 | 1 | 7 | 5 | 7 | 9 | 8 | 0 | 8 | 3 | 8 | 6 | 8 | 9 |
| 13 | 6 | 14 | 3 | 15 | 0 | 15 | 7 | 16 | 3 | 16 | 11 | 17 | 6 | 18 | 0 | 18 | 7 | 19 | 2 |
| 11 | 9 | 12 | 5 | 13 | 0 | 13 | 7 | 14 | 1 | 14 | 9 | 15 | 2 | 15 | 9 | 16 | 2 | 16 | 8 |
| 9 | 7 | 10 | 1 | 10 | 7 | 11 | 1 | 11 | 6 | 12 | 0 | 12 | 4 | 12 | 10 | 13 | 2 | 13 | 6 |
| 18 | 1 | 19 | 1 | 20 | 0 | 20 | 11 | 21 | 10 | 22 | 6 | 23 | 4 | 24 | 1 | 24 | 10 | 25 | 7 |
| 15 | 9 | 16 | 7 | 17 | 5 | 18 | 2 | 18 | 11 | 19 | 8 | 20 | 4 | 21 | 0 | 21 | 8 | 22 | 3 |
| 12 | 10 | 13 | 6 | 14 | 2 | 14 | 10 | 15 | 5 | 15 | 11 | 16 | 6 | 17 | 1 | 17 | 7 | 18 | 2 |
| 22 | 11 | 24 | 2 | 25 | 4 | 26 | 5 | 27 | 6 | 28 | 7 | 29 | 6 | 30 | 6 | 31 | 5 | 32 | 5 |
| 19 | 11 | 21 | 0 | 22 | 0 | 23 | 0 | 24 | 0 | 24 | 11 | 25 | 8 | 26 | 6 | 27 | 4 | 28 | 3 |
| 16 | 3 | 17 | 1 | 17 | 11 | 18 | 9 | 19 | 6 | 20 | 3 | 20 | 11 | 21 | 7 | 22 | 3 | 22 | 11 |

*between 10½ in 12 and 3 in 12, light roofing material* [2]

live load is 30 lb/ft²]

| Span [3] determined by bending when fiber stress in pounds per square inch is—Continued | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 7 | 11 | 8 | 4 | 8 | 9 | 9 | 2 | 9 | 6 | 9 | 11 | 10 | 3 | 10 | 7 | 10 | 11 | 11 | 2 |
| 6 | 11 | 7 | 3 | 7 | 7 | 8 | 0 | 8 | 4 | 8 | 7 | 8 | 11 | 9 | 2 | 9 | 6 | 9 | 9 |
| 5 | 7 | 5 | 11 | 6 | 2 | 6 | 6 | 6 | 9 | 7 | 0 | 7 | 3 | 7 | 6 | 7 | 9 | 7 | 11 |
| 12 | 4 | 13 | 0 | 13 | 7 | 14 | 2 | 14 | 10 | 15 | 4 | 15 | 11 | 16 | 5 | 16 | 11 | 17 | 5 |
| 10 | 8 | 11 | 3 | 11 | 10 | 12 | 4 | 12 | 10 | 13 | 4 | 13 | 10 | 14 | 3 | 14 | 9 | 15 | 1 |
| 8 | 8 | 9 | 2 | 9 | 7 | 10 | 0 | 10 | 6 | 10 | 10 | 11 | 3 | 11 | 7 | 12 | 0 | 12 | 4 |
| 16 | 5 | 17 | 4 | 18 | 2 | 18 | 11 | 19 | 9 | 20 | 6 | 21 | 3 | 21 | 11 | 22 | 7 | 23 | 3 |
| 14 | 3 | 15 | 1 | 15 | 9 | 16 | 6 | 17 | 2 | 17 | 10 | 18 | 5 | 19 | 0 | 19 | 7 | 20 | 3 |
| 11 | 7 | 12 | 3 | 12 | 10 | 13 | 5 | 13 | 11 | 14 | 6 | 15 | 0 | 15 | 6 | 15 | 11 | 16 | 5 |
| 20 | 10 | 21 | 11 | 22 | 11 | 24 | 0 | 25 | 0 | 25 | 11 | 26 | 10 | 27 | 9 | 28 | 6 | 29 | 5 |
| 18 | 1 | 19 | 1 | 20 | 0 | 20 | 10 | 21 | 9 | 22 | 6 | 23 | 4 | 24 | 1 | 24 | 10 | 25 | 6 |
| 14 | 9 | 15 | 6 | 16 | 3 | 17 | 0 | 17 | 9 | 18 | 4 | 18 | 11 | 19 | 7 | 20 | 3 | 20 | 10 |

TABLE 11.—*Maximum spans [1] for roof rafters for slopes*

[For localities where maximum

| Size (nominal) | Spacing | Span [3] determined by bending when working stress [4] in pounds per square inch is— | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | | 300 | | 400 | | 500 | | 600 | | 700 | | 800 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 5 | 0 | 6 | 2 | 7 | 1 | 8 | 11 | 8 | 9 | 9 | 5 | 10 | 1 |
| | 16 | 4 | 5 | 5 | 4 | 6 | 2 | 6 | 11 | 7 | 7 | 8 | 3 | 8 | 9 |
| | 24 | 3 | 7 | 4 | 4 | 5 | 0 | 5 | 8 | 6 | 2 | 6 | 8 | 7 | 1 |
| 2×6 | 12 | 7 | 10 | 9 | 7 | 11 | 0 | 12 | 4 | 13 | 6 | 14 | 7 | 15 | 7 |
| | 16 | 6 | 10 | 8 | 4 | 9 | 7 | 10 | 9 | 11 | 9 | 12 | 9 | 13 | 7 |
| | 24 | 5 | 7 | 6 | 9 | 7 | 10 | 8 | 9 | 9 | 7 | 10 | 4 | 11 | 1 |
| 2×8 | 12 | 10 | 5 | 12 | 10 | 14 | 9 | 16 | 6 | 18 | 1 | 19 | 7 | 20 | 11 |
| | 16 | 9 | 1 | 11 | 2 | 12 | 11 | 14 | 5 | 15 | 9 | 17 | 0 | 18 | 2 |
| | 24 | 7 | 4 | 9 | 1 | 10 | 5 | 11 | 8 | 12 | 10 | 13 | 10 | 14 | 10 |
| 2×10 | 12 | 13 | 3 | 16 | 2 | 18 | 8 | 20 | 11 | 22 | 11 | 24 | 9 | 26 | 5 |
| | 16 | 11 | 6 | 14 | 2 | 16 | 3 | 18 | 2 | 19 | 11 | 21 | 6 | 23 | 0 |
| | 24 | 9 | 4 | 11 | 5 | 13 | 3 | 14 | 10 | 16 | 3 | 17 | 6 | 18 | 9 |

[1] This table is based upon FHA design recommendations as follows:
(a) Total load=28 lb/ft[2] acting normal to the roof.
(b) Span is the sloping length of rafter between supports.
[2] Weight of roofing material and roof construction=7 lb/ft[2].
[3] Maximum spans for working stresses which are between those tabulated shall be determined by interpolation.
[4] The tabulated spans are based upon fiber stresses which are 50% greater than the working stresses shown at the head of each column. See sec. 709-3.

TABLE 11a.—*Maximum spans [1] for roof rafters for slopes*

[For localities where maximum

| Size (nominal) | Spacing | Span [3] determined by bending when working stress [4] in pounds per square inch is— | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | | 300 | | 400 | | 500 | | 600 | | 700 | | 800 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 5 | 0 | 6 | 2 | 7 | 1 | 8 | 11 | 8 | 9 | 9 | 5 | 10 | 1 |
| | 16 | 4 | 5 | 5 | 4 | 6 | 2 | 6 | 11 | 7 | 7 | 8 | 3 | 8 | 9 |
| | 24 | 3 | 7 | 4 | 4 | 5 | 0 | 5 | 8 | 6 | 2 | 6 | 8 | 7 | 1 |
| 2×6 | 12 | 7 | 10 | 9 | 7 | 11 | 0 | 12 | 4 | 13 | 6 | 14 | 7 | 15 | 7 |
| | 16 | 6 | 10 | 8 | 4 | 9 | 7 | 10 | 9 | 11 | 9 | 12 | 9 | 13 | 7 |
| | 24 | 5 | 7 | 6 | 9 | 7 | 10 | 8 | 9 | 9 | 7 | 10 | 4 | 11 | 1 |
| 2×8 | 12 | 10 | 5 | 12 | 10 | 14 | 9 | 16 | 6 | 18 | 1 | 19 | 7 | 20 | 11 |
| | 16 | 9 | 1 | 11 | 2 | 12 | 11 | 14 | 5 | 15 | 9 | 17 | 0 | 18 | 2 |
| | 24 | 7 | 4 | 9 | 1 | 10 | 5 | 11 | 8 | 12 | 10 | 13 | 10 | 14 | 10 |
| 2×10 | 12 | 13 | 3 | 16 | 2 | 18 | 8 | 20 | 11 | 22 | 11 | 24 | 9 | 26 | 5 |
| | 16 | 11 | 6 | 14 | 2 | 16 | 3 | 18 | 2 | 19 | 11 | 21 | 6 | 23 | 0 |
| | 24 | 9 | 4 | 11 | 5 | 13 | 3 | 14 | 10 | 16 | 3 | 17 | 6 | 18 | 9 |

[1] This table is based upon FHA design recommendations as follows:
(a) Total load=28 lb/ft[2] acting normal to the roof.
(b) Span is the sloping length of the rafter between supports.
[2] Weight of roofing material and roof construction=7 lb/ft[2].
[3] Maximum spans for working stresses which are between those tabulated shall be determined by interpolation.
[4] The tabulated spans are based upon fiber stresses which are 50% greater than the working stresses shown at the head of each column. See sec. 709-3.

*of 8½ in 12 and greater, light roofing material* [2]

live load is 20 lb/ft [2]]

Span [3] determined by bending when working stress [4] in pounds per square inch is—Continued

| 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 10 | 8 | 11 | 4 | 11 | 10 | 12 | 4 | 12 | 10 | 13 | 4 | 13 | 10 | 14 | 3 | 14 | 8 | 15 | 1 |
| 9 | 4 | 9 | 10 | 10 | 4 | 10 | 9 | 11 | 2 | 11 | 7 | 12 | 0 | 12 | 5 | 12 | 9 | 13 | 2 |
| 7 | 7 | 8 | 0 | 8 | 4 | 8 | 9 | 9 | 1 | 9 | 5 | 9 | 9 | 10 | 1 | 10 | 5 | 10 | 8 |
| 16 | 7 | 17 | 6 | 18 | 4 | 19 | 2 | 19 | 11 | 20 | 8 | 21 | 5 | 22 | 2 | 22 | 11 | 23 | 6 |
| 14 | 5 | 15 | 2 | 16 | 0 | 16 | 8 | 17 | 5 | 18 | 0 | 18 | 8 | 19 | 3 | 19 | 10 | 20 | 5 |
| 11 | 9 | 12 | 4 | 12 | 11 | 13 | 6 | 14 | 1 | 14 | 8 | 15 | 2 | 15 | 8 | 16 | 2 | 16 | 7 |
| 22 | 2 | 23 | 4 | 24 | 6 | 25 | 7 | 26 | 7 | 27 | 7 | 28 | 7 | 29 | 6 | 30 | 5 | 31 | 4 |
| 19 | 4 | 20 | 4 | 21 | 4 | 22 | 3 | 23 | 2 | 24 | 0 | 24 | 11 | 25 | 9 | 26 | 6 | 27 | 4 |
| 15 | 8 | 16 | 6 | 17 | 4 | 18 | 2 | 18 | 10 | 19 | 7 | 20 | 2 | 20 | 11 | 21 | 7 | 22 | 2 |
| 28 | 0 | 29 | 6 | 31 | 1 | 32 | 5 | 33 | 10 | 35 | 0 | 36 | 3 | 37 | 6 | 38 | 8 | 39 | 10 |
| 24 | 5 | 25 | 8 | 27 | 0 | 28 | 3 | 29 | 4 | 30 | 5 | 31 | 7 | 32 | 7 | 33 | 7 | 34 | 6 |
| 19 | 10 | 20 | 11 | 22 | 0 | 22 | 11 | 23 | 11 | 24 | 10 | 25 | 8 | 26 | 6 | 27 | 3 | 28 | 1 |

*of 10½ in 12 and greater, light roofing material* [2]

live load is 30 lb/ft [2]]

Span [3] determined by bending when working stress [4] in pounds per square inch is—Continued

| 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 10 | 8 | 11 | 4 | 11 | 10 | 12 | 4 | 12 | 10 | 13 | 4 | 13 | 10 | 14 | 3 | 14 | 8 | 15 | 1 |
| 9 | 4 | 9 | 10 | 10 | 4 | 10 | 9 | 11 | 2 | 11 | 7 | 12 | 0 | 12 | 5 | 12 | 9 | 13 | 2 |
| 7 | 7 | 8 | 0 | 8 | 4 | 8 | 9 | 9 | 1 | 9 | 5 | 9 | 9 | 10 | 1 | 10 | 5 | 10 | 8 |
| 16 | 7 | 17 | 6 | 18 | 4 | 19 | 2 | 19 | 11 | 20 | 8 | 21 | 5 | 22 | 2 | 22 | 11 | 23 | 6 |
| 14 | 5 | 15 | 2 | 16 | 0 | 16 | 8 | 17 | 5 | 18 | 0 | 18 | 8 | 19 | 3 | 19 | 10 | 20 | 5 |
| 11 | 9 | 12 | 4 | 12 | 11 | 13 | 6 | 14 | 1 | 14 | 8 | 15 | 2 | 15 | 8 | 16 | 2 | 16 | 7 |
| 22 | 2 | 23 | 4 | 24 | 6 | 25 | 7 | 26 | 7 | 27 | 7 | 28 | 7 | 29 | 6 | 30 | 5 | 31 | 4 |
| 19 | 4 | 20 | 4 | 21 | 4 | 22 | 3 | 23 | 2 | 24 | 0 | 24 | 11 | 25 | 9 | 26 | 6 | 27 | 4 |
| 15 | 8 | 16 | 6 | 17 | 4 | 18 | 2 | 18 | 10 | 19 | 7 | 20 | 2 | 20 | 11 | 21 | 7 | 22 | 2 |
| 28 | 0 | 29 | 6 | 31 | 1 | 32 | 5 | 33 | 10 | 35 | 0 | 36 | 3 | 37 | 6 | 38 | 8 | 39 | 10 |
| 24 | 5 | 25 | 8 | 27 | 0 | 28 | 3 | 29 | 4 | 30 | 5 | 31 | 7 | 32 | 7 | 33 | 7 | 34 | 6 |
| 19 | 10 | 20 | 11 | 22 | 0 | 22 | 11 | 23 | 11 | 24 | 10 | 25 | 8 | 26 | 6 | 27 | 3 | 28 | 1 |

TABLE 12.—*Maximum spans* [1] *for roof rafters for slopes*

[For localities wbere maximum

| Size (nominal) | Spacing | Span [3] determined by bending when working stress in pounds per square inch is— | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | | 300 | | 400 | | 500 | | 600 | | 700 | | 800 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 3 | 9 | 4 | 7 | 5 | 4 | 5 | 11 | 6 | 6 | 7 | 0 | 7 | 6 |
| | 16 | 3 | 3 | 4 | 0 | 4 | 7 | 5 | 1 | 5 | 8 | 6 | 1 | 6 | 6 |
| | 24 | 2 | 8 | 3 | 3 | 3 | 9 | 4 | 2 | 4 | 7 | 4 | 11 | 5 | 3 |
| 2×6 | 12 | 5 | 10 | 7 | 1 | 8 | 2 | 9 | 2 | 10 | 0 | 10 | 10 | 11 | 7 |
| | 16 | 5 | 0 | 6 | 2 | 7 | 1 | 7 | 11 | 8 | 8 | 9 | 5 | 10 | 0 |
| | 24 | 4 | 1 | 5 | 0 | 5 | 10 | 6 | 6 | 7 | 1 | 7 | 8 | 8 | 2 |
| 2×8 | 12 | 7 | 9 | 9 | 5 | 10 | 11 | 12 | 3 | 13 | 5 | 14 | 6 | 15 | 6 |
| | 16 | 6 | 9 | 8 | 3 | 9 | 6 | 10 | 7 | 11 | 8 | 12 | 8 | 13 | 6 |
| | 24 | 5 | 5 | 6 | 9 | 7 | 9 | 8 | 8 | 9 | 5 | 10 | 3 | 10 | 11 |
| 2×10 | 12 | 9 | 10 | 12 | 0 | 13 | 10 | 15 | 6 | 17 | 0 | 18 | 4 | 19 | 7 |
| | 16 | 8 | 7 | 10 | 5 | 12 | 1 | 13 | 5 | 14 | 9 | 16 | 0 | 17 | 1 |
| | 24 | 6 | 11 | 8 | 6 | 9 | 10 | 10 | 11 | 12 | 0 | 13 | 0 | 13 | 10 |

[1] This table is based upon FHA design recommendations as follows:
(a) Total load=34 lb/ft² acting vertically.
(b) Span is the horizontal projection of tbe rafter between supports.
[2] Weigbt of roofing material and roof construction=12.5 lb/ft².
[3] Maximum spans for working stresses wbicb are between tbose tabulatcd sball be determined by interpolation.

TABLE 12a.—*Maximum spans* [1] *for roof rafters for slopes*

[For localities where maximum

| Size (nominal) | Spacing | Span [3] determined by bending when working stress in pounds per square inch is— | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | | 300 | | 400 | | 500 | | 600 | | 700 | | 800 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 3 | 5 | 4 | 3 | 4 | 11 | 5 | 5 | 6 | 0 | 6 | 5 | 6 | 11 |
| | 16 | 3 | 0 | 3 | 8 | 4 | 3 | 4 | 9 | 5 | 2 | 5 | 7 | 6 | 0 |
| | 24 | 2 | 6 | 3 | 0 | 3 | 5 | 3 | 11 | 4 | 3 | 4 | 7 | 4 | 11 |
| 2×6 | 12 | 5 | 4 | 6 | 7 | 7 | 7 | 8 | 6 | 9 | 3 | 10 | 0 | 10 | 8 |
| | 16 | 4 | 8 | 5 | 8 | 6 | 7 | 7 | 4 | 8 | 1 | 8 | 8 | 9 | 4 |
| | 24 | 3 | 10 | 4 | 8 | 5 | 4 | 6 | 0 | 6 | 7 | 7 | 1 | 7 | 7 |
| 2×8 | 12 | 7 | 2 | 8 | 9 | 10 | 1 | 11 | 3 | 12 | 4 | 13 | 4 | 14 | 3 |
| | 16 | 6 | 3 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 9 | 11 | 7 | 12 | 5 |
| | 24 | 5 | 1 | 6 | 2 | 7 | 2 | 8 | 0 | 8 | 9 | 9 | 5 | 10 | 1 |
| 2×10 | 12 | 9 | 0 | 11 | 1 | 12 | 9 | 14 | 4 | 15 | 8 | 16 | 11 | 18 | 1 |
| | 16 | 7 | 10 | 9 | 8 | 11 | 1 | 12 | 5 | 13 | 7 | 14 | 8 | 15 | 9 |
| | 24 | 6 | 4 | 7 | 10 | 9 | 0 | 10 | 1 | 11 | 1 | 11 | 11 | 12 | 9 |

[1] This table is based upon FHA design recommendations as follows:
(a) Total load=40 lb/ft² acting vertically.
(b) Span is the horizontal projection of the rafter between supports.
[2] Weigbt of roofing material and roof construction=12.5 lb/ft².
[3] Maximum spans for working stresses wbich are between those tabulated shall be determined by interpolation.

*between 8½ in 12 and 3 in 12, heavy roofing material* [2]

live load is 20 lb/ft²]

| Span [3] determined by bending when working stress in pounds per square inch is—Continued | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 7 | 11 | 8 | 4 | 8 | 9 | 9 | 2 | 9 | 6 | 9 | 11 | 10 | 3 | 10 | 7 | 10 | 11 | 11 | 2 |
| 6 | 11 | 7 | 3 | 7 | 7 | 8 | 0 | 8 | 4 | 8 | 7 | 8 | 11 | 9 | 2 | 9 | 6 | 9 | 9 |
| 5 | 7 | 5 | 11 | 6 | 2 | 6 | 6 | 6 | 9 | 7 | 0 | 7 | 3 | 7 | 6 | 7 | 9 | 7 | 11 |
| 12 | 4 | 13 | 0 | 13 | 7 | 14 | 2 | 14 | 10 | 15 | 4 | 15 | 11 | 16 | 5 | 16 | 11 | 17 | 5 |
| 10 | 8 | 11 | 3 | 11 | 10 | 12 | 4 | 12 | 10 | 13 | 4 | 13 | 10 | 14 | 3 | 14 | 9 | 15 | 1 |
| 8 | 8 | 9 | 2 | 9 | 7 | 10 | 0 | 10 | 6 | 10 | 10 | 11 | 3 | 11 | 7 | 12 | 0 | 12 | 4 |
| 16 | 5 | 17 | 4 | 18 | 2 | 18 | 11 | 19 | 9 | 20 | 6 | 21 | 3 | 21 | 11 | 22 | 7 | 23 | 3 |
| 14 | 3 | 15 | 1 | 15 | 9 | 16 | 6 | 17 | 2 | 17 | 10 | 18 | 5 | 19 | 0 | 19 | 7 | 20 | 3 |
| 11 | 7 | 12 | 3 | 12 | 10 | 13 | 5 | 13 | 11 | 14 | 6 | 15 | 0 | 15 | 6 | 15 | 11 | 16 | 5 |
| 20 | 10 | 21 | 11 | 22 | 11 | 24 | 0 | 25 | 0 | 25 | 11 | 26 | 10 | 27 | 9 | 28 | 6 | 29 | 5 |
| 18 | 1 | 19 | 1 | 20 | 0 | 20 | 10 | 21 | 9 | 22 | 6 | 23 | 4 | 24 | 1 | 24 | 10 | 25 | 6 |
| 14 | 9 | 15 | 6 | 16 | 3 | 17 | 0 | 17 | 9 | 18 | 4 | 18 | 11 | 19 | 7 | 20 | 3 | 20 | 10 |

*between 10½ in 12 and 3 in 12, heavy roofing material* [2]

live load is 30 lb/ft²]

| Span [3] determined by bending when working stress in pounds per square inch is—Continued | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 7 | 4 | 7 | 8 | 8 | 1 | 8 | 5 | 8 | 9 | 9 | 2 | 9 | 5 | 9 | 9 | 10 | 1 | 10 | 4 |
| 6 | 4 | 6 | 8 | 7 | 0 | 7 | 4 | 7 | 8 | 7 | 11 | 8 | 2 | 8 | 6 | 8 | 9 | 9 | 0 |
| 5 | 2 | 5 | 6 | 5 | 9 | 6 | 0 | 6 | 3 | 6 | 6 | 6 | 8 | 6 | 11 | 7 | 1 | 7 | 4 |
| 11 | 4 | 12 | 0 | 12 | 6 | 13 | 1 | 13 | 8 | 14 | 2 | 14 | 8 | 15 | 1 | 15 | 7 | 16 | 0 |
| 9 | 10 | 10 | 5 | 10 | 11 | 11 | 5 | 11 | 10 | 12 | 4 | 12 | 8 | 13 | 1 | 13 | 6 | 13 | 11 |
| 8 | 0 | 8 | 6 | 8 | 11 | 9 | 4 | 9 | 8 | 10 | 0 | 10 | 4 | 10 | 8 | 11 | 0 | 11 | 4 |
| 15 | 2 | 15 | 11 | 16 | 9 | 17 | 6 | 18 | 2 | 18 | 11 | 19 | 7 | 20 | 3 | 20 | 10 | 21 | 5 |
| 13 | 2 | 13 | 10 | 14 | 7 | 15 | 2 | 15 | 10 | 16 | 5 | 17 | 0 | 17 | 7 | 18 | 1 | 18 | 7 |
| 10 | 8 | 11 | 3 | 11 | 10 | 12 | 4 | 12 | 11 | 13 | 5 | 13 | 10 | 14 | 3 | 14 | 8 | 15 | 1 |
| 19 | 3 | 20 | 3 | 21 | 2 | 22 | 1 | 23 | 0 | 23 | 11 | 24 | 9 | 25 | 6 | 26 | 4 | 27 | 1 |
| 16 | 8 | 17 | 7 | 18 | 5 | 19 | 3 | 20 | 0 | 20 | 9 | 21 | 6 | 22 | 3 | 22 | 10 | 23 | 6 |
| 13 | 7 | 14 | 4 | 15 | 0 | 15 | 8 | 16 | 3 | 16 | 11 | 17 | 6 | 18 | 1 | 18 | 7 | 19 | 1 |

TABLE 13.—*Maximum spans* [1] *for roof rafters for slopes*

[For localities where maximum

| Size (nominal) | Spacing | Span [3] determined by bending when working stress [4] in pounds per square inch is— | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | | 300 | | 400 | | 500 | | 600 | | 700 | | 800 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 4 | 7 | 5 | 7 | 6 | 6 | 7 | 3 | 7 | 11 | 8 | 7 | 9 | 2 |
| | 16 | 4 | 0 | 4 | 10 | 5 | 8 | 6 | 3 | 6 | 11 | 7 | 5 | 8 | 0 |
| | 24 | 3 | 3 | 3 | 11 | 4 | 7 | 5 | 1 | 5 | 7 | 6 | 0 | 6 | 6 |
| 2×6 | 12 | 7 | 1 | 8 | 9 | 10 | 0 | 11 | 3 | 12 | 4 | 13 | 4 | 14 | 2 |
| | 16 | 6 | 2 | 7 | 6 | 8 | 8 | 9 | 9 | 10 | 8 | 11 | 6 | 12 | 4 |
| | 24 | 5 | 0 | 6 | 2 | 7 | 1 | 7 | 11 | 8 | 8 | 9 | 5 | 10 | 0 |
| 2×8 | 12 | 9 | 5 | 11 | 8 | 13 | 5 | 15 | 0 | 16 | 5 | 17 | 9 | 18 | 11 |
| | 16 | 8 | 3 | 10 | 1 | 11 | 8 | 13 | 0 | 14 | 3 | 15 | 5 | 16 | 6 |
| | 24 | 6 | 9 | 8 | 3 | 9 | 5 | 10 | 8 | 11 | 7 | 12 | 7 | 13 | 5 |
| 2×10 | 12 | 12 | 0 | 14 | 9 | 17 | 0 | 19 | 0 | 20 | 10 | 22 | 6 | 24 | 0 |
| | 16 | 10 | 5 | 12 | 9 | 14 | 9 | 16 | 6 | 18 | 1 | 19 | 6 | 20 | 10 |
| | 24 | 8 | 6 | 10 | 5 | 12 | 0 | 13 | 5 | 14 | 9 | 15 | 11 | 17 | 0 |

[1] This table is based upon FHA design recommendations as follows:
(a) Total load=34 lb/ft² acting normal to the roof.
(b) Span is the sloping length of rafter between supports.
[2] Weight of roofing material and roof construction=12.5 lb/ft².
[3] Maximum spans for working stresses which are between those tabulated shall be determined by interpolation.
[4] The tabulated spans are based upon fiber stresses which are 50% greater than the working stresses shown at the head of each column. See sec. 709–3.

TABLE 13a.—*Maximum spans* [1] *for roof rafters for*

[For localities where maximum

| Size (nominal) | Spacing | Span [3] determined by bending when working stress [4] in pounds per square inch is— | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | | 300 | | 400 | | 500 | | 600 | | 700 | | 800 | |
| *in.* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 2×4 | 12 | 4 | 7 | 5 | 7 | 6 | 6 | 7 | 3 | 7 | 11 | 8 | 7 | 9 | 2 |
| | 16 | 4 | 0 | 4 | 10 | 5 | 8 | 6 | 3 | 6 | 11 | 7 | 5 | 8 | 0 |
| | 24 | 3 | 3 | 3 | 11 | 4 | 7 | 5 | 1 | 5 | 7 | 6 | 0 | 6 | 6 |
| 2×6 | 12 | 7 | 1 | 8 | 9 | 10 | 0 | 11 | 3 | 12 | 4 | 13 | 4 | 14 | 2 |
| | 16 | 6 | 2 | 7 | 6 | 8 | 8 | 9 | 9 | 10 | 8 | 11 | 6 | 12 | 4 |
| | 24 | 5 | 0 | 6 | 2 | 7 | 1 | 7 | 11 | 8 | 8 | 9 | 5 | 10 | 0 |
| 2×8 | 12 | 9 | 5 | 11 | 8 | 13 | 5 | 15 | 0 | 16 | 5 | 17 | 9 | 18 | 11 |
| | 16 | 8 | 3 | 10 | 1 | 11 | 8 | 13 | 0 | 14 | 3 | 15 | 5 | 16 | 6 |
| | 24 | 6 | 9 | 8 | 3 | 9 | 5 | 10 | 8 | 11 | 7 | 12 | 7 | 13 | 5 |
| 2×10 | 12 | 12 | 0 | 14 | 9 | 17 | 0 | 19 | 0 | 20 | 10 | 22 | 6 | 24 | 0 |
| | 16 | 10 | 5 | 12 | 9 | 14 | 9 | 16 | 6 | 18 | 1 | 19 | 6 | 20 | 10 |
| | 24 | 8 | 6 | 10 | 5 | 12 | 0 | 13 | 5 | 14 | 9 | 15 | 11 | 17 | 0 |

[1] This table is based upon FHA design recommendations as follows:
(a) Total load=34 lb/ft² acting normal to the roof.
(b) Span is the sloping length of rafter between supports.
[2] Weight of roofing material and roof construction=12.5 lb/ft².
[3] Maximum spans for working stresses which are between those tabulated shall be determined by interpolation.
[4] The tabulated spans are based upon fiber stresses which are 50% greater than the working stresses shown at the head of each column. See sec. 709–3.

*of 8½ in 12 and greater, heavy roofing material* [2]

live load is 20 lb/ft²]

| Span [3] determined by bending when working stress [4] in pounds per square inch is—Continued | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 9 | 9 | 10 | 3 | 10 | 9 | 11 | 2 | 11 | 8 | 12 | 1 | 12 | 6 | 12 | 11 | 13 | 4 | 13 | 9 |
| 8 | 5 | 8 | 11 | 9 | 4 | 9 | 9 | 10 | 1 | 10 | 6 | 10 | 11 | 11 | 3 | 11 | 7 | 11 | 11 |
| 6 | 10 | 7 | 3 | 7 | 7 | 7 | 11 | 8 | 3 | 8 | 7 | 8 | 10 | 9 | 2 | 9 | 5 | 9 | 9 |
| 15 | 1 | 15 | 11 | 16 | 8 | 17 | 5 | 18 | 2 | 18 | 9 | 19 | 6 | 20 | 1 | 20 | 9 | 21 | 4 |
| 13 | 1 | 13 | 10 | 14 | 6 | 15 | 1 | 15 | 9 | 16 | 4 | 16 | 11 | 17 | 6 | 18 | 0 | 18 | 6 |
| 10 | 8 | 11 | 3 | 11 | 9 | 12 | 4 | 12 | 10 | 13 | 4 | 13 | 9 | 14 | 3 | 14 | 8 | 15 | 1 |
| 20 | 1 | 21 | 3 | 22 | 3 | 23 | 3 | 24 | 2 | 25 | 0 | 26 | 0 | 26 | 10 | 27 | 9 | 28 | 5 |
| 17 | 6 | 18 | 5 | 19 | 4 | 20 | 3 | 21 | 0 | 21 | 10 | 22 | 7 | 23 | 4 | 24 | 0 | 24 | 9 |
| 14 | 3 | 15 | 0 | 15 | 9 | 16 | 5 | 17 | 1 | 17 | 9 | 18 | 4 | 19 | 0 | 19 | 7 | 20 | 1 |
| 25 | 5 | 26 | 10 | 28 | 2 | 29 | 5 | 30 | 7 | 31 | 9 | 32 | 11 | 34 | 0 | 35 | 0 | 36 | 0 |
| 22 | 1 | 23 | 4 | 24 | 6 | 25 | 6 | 26 | 7 | 27 | 8 | 28 | 7 | 29 | 7 | 30 | 6 | 31 | 4 |
| 18 | 0 | 18 | 11 | 19 | 11 | 20 | 10 | 21 | 9 | 22 | 5 | 23 | 3 | 24 | 0 | 24 | 10 | 25 | 6 |

*slopes of 10½ in 12 and greater, heavy roofing material* [2]

live load is 30 lb/ft²]

| Span [3] determined by bending when working stress [4] in pounds per square inch is—Continued | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 900 | | 1,000 | | 1,100 | | 1,200 | | 1,300 | | 1,400 | | 1,500 | | 1,600 | | 1,700 | | 1,800 | |
| *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* | *ft* | *in.* |
| 9 | 9 | 10 | 3 | 10 | 9 | 11 | 2 | 11 | 8 | 12 | 1 | 12 | 6 | 12 | 11 | 13 | 4 | 13 | 9 |
| 8 | 5 | 8 | 11 | 9 | 4 | 9 | 9 | 10 | 1 | 10 | 6 | 10 | 11 | 11 | 3 | 11 | 7 | 11 | 11 |
| 6 | 10 | 7 | 3 | 7 | 7 | 7 | 11 | 8 | 3 | 8 | 7 | 8 | 10 | 9 | 2 | 9 | 5 | 9 | 9 |
| 15 | 1 | 15 | 11 | 16 | 8 | 17 | 5 | 18 | 2 | 18 | 9 | 19 | 6 | 20 | 1 | 20 | 9 | 21 | 4 |
| 13 | 1 | 13 | 10 | 14 | 6 | 15 | 1 | 15 | 9 | 16 | 4 | 16 | 11 | 17 | 6 | 18 | 0 | 18 | 6 |
| 10 | 8 | 11 | 3 | 11 | 9 | 12 | 4 | 12 | 10 | 13 | 4 | 13 | 9 | 14 | 3 | 14 | 8 | 15 | 1 |
| 20 | 1 | 21 | 3 | 22 | 3 | 23 | 3 | 24 | 2 | 25 | 0 | 26 | 0 | 26 | 10 | 27 | 9 | 28 | 5 |
| 17 | 6 | 18 | 5 | 19 | 4 | 20 | 3 | 21 | 0 | 21 | 10 | 22 | 7 | 23 | 4 | 24 | 0 | 24 | 9 |
| 14 | 3 | 15 | 0 | 15 | 9 | 16 | 5 | 17 | 1 | 17 | 9 | 18 | 4 | 19 | 0 | 19 | 7 | 20 | 1 |
| 25 | 5 | 26 | 10 | 28 | 2 | 29 | 5 | 30 | 7 | 31 | 9 | 32 | 11 | 34 | 0 | 35 | 0 | 36 | 0 |
| 22 | 1 | 23 | 4 | 24 | 6 | 25 | 6 | 26 | 7 | 27 | 8 | 28 | 7 | 29 | 7 | 30 | 6 | 31 | 4 |
| 18 | 0 | 18 | 11 | 19 | 11 | 20 | 10 | 21 | 9 | 22 | 5 | 23 | 3 | 24 | 0 | 24 | 10 | 25 | 6 |

### Paragraph 709–6 (a). Load-Carrying Capacity

Walls constructed with 2- by 4-inch studs of average quality, spaced 16 inches on centers and well tied and braced, constitute one form of construction that will meet the load requiredments of this Code. For one-story buildings a stud spacing of 2 feet is adequate.

### Paragraph 709–6 (d). Stucco on Wood-Frame Construction

In back-plastered construction, the base for the stucco is attached directly to the studs. Adequate bracing is necessary with this type of construction.

### Paragraph 709–6 (h). Framing over Openings in Bearing Walls

The requirements of Section 709–6 (h) regarding lintels will be met by the use of the following formula:

$$\text{Span} = \text{nominal height in inches} \times \sqrt{\frac{T}{3\frac{1}{4}} \times \frac{50}{\text{given load}} \times \frac{\text{given stress}}{1{,}200} \times \frac{16}{\text{given joist span}}},$$

in which

$T$ = total actual thickness of members comprising lintel;

Given load = total load per square foot of floor area.

For lintels over openings in bearing partitions, the span of the joists shall be taken as the sum of the spans on the two sides of the partition.

Care must be exercised to see that the safe horizontal-shear stress is not exceeded. This is likely to occur whenever the product of the quantities under the radical is less than 1.

The nailing at the ends of lintels may be the same as for headers; but a better construction for heavy vertical loads is to double the studs from the support to the underside of the lintel and, in addition, to nail each end of each lintel member with two twentypenny nails if 2- by 4-inch material is used and with at least three twentypenny nails if 2- by 6-inch material or larger is used.

### Paragraph 709–8 (b). Headers and Trimmers

Not more than five tail beams should be framed to a header when the trimmers are of the same size as the joists which are of the minimum size and strength permitted by the Code. Six tail beams are permitted when the joists and trimmers are of the next standard height greater or if the trimmers are 25 percent stronger than is required for the joists.

Not more than two tail beams should be framed to the header on each side of the opening when the trimmers are of the same size as the joists which are of the minimum size and strength permitted by the Code. Three tail beams are permitted on each side of the opening if the joists are of the next standard height greater or if the trimmers are 25 percent stronger than are required for the joists. Four tail beams are permitted if the trimmers are both higher and stronger, as given above.

Framing around openings larger than above or details not covered should be designed by a competent engineer.

The tail beams of 2-inch thickness in ordinary dwellings, when 6 inches or more in height and supported by nails, should have not less than three twentypenny nails through the first header into each tail beam nor less than one twentypenny nail for each 4 square feet of floor supported by the tail beam. The second header should be nailed through the first header into the tail beam by not less than two-thirds as many twentypenny nails as were required in nailing the first header to the tail beams.

The headers should be nailed to the first trimmer by not less than three twentypenny nails through the first trimmer into each end of each header. The total number of nails into each end of the header, through the first trimmer, should be not less than one for each 8 square feet of floor supported by the tail beams. The second trimmer should be nailed through the first trimmer and into the headers with not less than two-thirds as many nails as are required for the first trimmer to the header.

Toe nailing or other means of support may be substituted for the direct nailing given above provided it has at least the strength and rigidity offered by the required nailing given above.

### Paragraph 709–8 (c). Collar Beams and Tie Beams

The minimum size of collar beams should be 1 inch by 6 inches or 2 by 4 inches, with maximum spacing of 5 feet. When ceiling joists do not serve as a tie at the plate line, ceiling joists or other ties on each pair of rafters are necessary somewhere below the upper third and they should be well spiked to each rafter. Special provision for tying the lower ends of the rafters to the floor or wall construction should also be made.

### Paragraph 709–8 (d). Bridging

A line of bridging should be provided at all supports where adequate stiffening is not otherwise provided.

### Paragraph 709–9. Plank-and-Beam Construction

In addition to the specific requirements of Section 709–9, the following procedure should be observed:

When beams are built of two or more laminations, all laminations should be securely spiked together from both outside faces. The ends of each lamination should bear on a support. When beam laminations are spaced to allow passage of utilities or for other reasons, they should be blocked at frequent intervals at each space between laminations and each lamination should be securely nailed to the blocking.

To avoid undue contraction after laying, plank should be protected from the elements during storage and construction.

Finish flooring, when used, should be not less than $\frac{13}{16}$ inch thick and should be laid at right angles with the plank of the subfloor over building paper or felt.

In two-story plank-and-beam construction, the studs at the second floor should be cut and capped with a plate to provide bearing for second-floor beams. Solid blocking or fillers whose depth is equal to that of the second-floor beam should be provided between beams and members of spaced beams at the exterior wall. The studs should bear on a plate laid on the plank flooring which extends to the outside wall.

Solid or built-up posts supporting beams should be squared at both ends to provide full bearing.

Plank-and-beam construction may be used for the first floor in conjunction with conventionally framed second floors, roofs, or ceilings. Where conventional joist framing is used above the first floor, the requirements already set forth for framed construction should apply.

When joisted construction is used in the second floor in conjunction with plank-and-beam construction in the first floor, bearing partitions should be placed directly over beams whose section has been increased sufficiently to carry the additional load, or special framing, either within the bearing partition or in the supporting floor system, should be provided to carry the additional load.

Interior columns should be designed to support adequately their loads, and the column ends should be squared to provide uniform bearing for the beams. Provision should be made for adequate bearing under beams by suitable column dimensions, suitable corbels or caps, by notching the columns, or by spiking bearing blocks not less than 2 feet long to the sides of the column.

### Paragraph 709–10 (a). Material

Commercial Standard CS45–40 "Douglas Fir Plywood (Domestic Grades)" is obtainable from the Superintendent of Documents, Washington, D. C., for 5 cents.

### Paragraph 709–10 (b). Gluing Plywood to Framing Members

Navy Department Specification 52G8b, July 1, 1932, "Glue, Casein, Water-Resistant" is obtainable from the Bureau of Supplies and Accounts, Navy Department, Washington, D. C.

Navy Aeronautical Specification G–29, April 4, 1941, "Glue, Cold Setting Resin" is obtainable from the Naval Aircraft Factory, U. S. Navy Yard, Philadelphia, Pa.

### Paragraph 709–10 (c). Design of Flat Panel With Stressed Coverings

The safe stress and methods of calculating the stress in a flat panel with stressed covering as given below apply only to panels with plywood covering glued to longitudinal wood members.

(*1*) *Construction features.*—The gluing between the frame and plywood covers and also between plywood laminations should be good.[25]

[25] It is essential to have good gluing between the frame and the covering, and it is almost equally important to have good bond and strength within the covering.

The longitudinal members should be at least twice as thick (cross-sectional dimension next to the covering) as the thicker covering.

Headers must be provided with longitudinal members whose ratio of height to thickness is 2 or more.

(*2*) *Strength and stiffness.*—In calculating the strength and stiffness of a plywood panel, any clear width of covering in excess of $b$ between any two longitudinal members should be neglected. Panels with a clear distance between longitudinal members over $2b$ should not be considered as having stressed covering. The value of $b$ shall be determined by the following formulas:

For three plies:

$$b=31h\sqrt{\frac{h}{\text{parallel plies thickness}}}$$

For five or more plies:

$$b=36h\sqrt{\frac{h}{\text{parallel plies thickness}}}$$

where $b$ = basic width between longitudinal members (clear distance, not center to center);
$h$ = thickness of plywood cover.

With $b$ determined for plywood as above, the strength and stiffness of the panel should be determined from the strength values for clear wood given in table 1. First calculate the moment of inertia of the section, neglecting the cross plies and all covering in excess of $b$. Then calculate the stiffness, using the modulus of elasticity for the species taken from table 1. In calculating the safe strength for spacing of longitudinal members one-half $b$ or less, use for high-grade plywood on the compressive face 85 percent, and for a medium grade of plywood 75 percent, of the basic stress in compression parallel to the grain, increased when used in a continuously dry location by 25 percent.

When the clear distance between the longitudinal members is greater than one-half $b$, reduce the stress uniformly from that allowed at one-half $b$ to two-thirds this amount at a spacing of $b$.

In calculating the strength on the tension face, use the basic stress in extreme fiber in bending (table 1) and proceed as above.

### Paragraph 709–11. Termites and Decay

For suggestions on suitable provisions for ventilation beneath buildings, the committee is indebted to the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture. Additional information will be found in Prevention and Control of Decay in Dwellings, Technical Note No. 251, issued by the Division of Forest Pathology of the United States Department of Agriculture and obtainable without charge from the Forest Products Laboratory, Madison, Wis.

For further information on methods of guarding against termites, see Insects in Relation to National Defense, Circular 2, and Supplement A thereto, issued in February and June 1941 by the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture.

The more decay-resistant species mentioned in Section 709–11 (h) include baldcypress, redwood, and cedar.

### Paragraph 800. General

The specifications referred to in Section 800 are obtainable from the American Society for Testing Materials, 260 South Broad Street, Philadelphia, Pa., for 25 cents.

### Paragraph 801. Fire Separation

In Section 801 and elsewhere in the Code, certain fire-resistance requirements for walls or partitions separating dwellings or dwelling units are given. For specific materials and thicknesses which will meet these requirements, reference should be made to publications on the subject, which include the following:

BH14, Recommended Minimum Requirements for Fire Resistance in Buildings;
BMS71, Fire Tests of Wood- and Metal-Framed Partitions;
BMS92, Fire Resistance Classifications of Building Constructions.

The first two publications are issued by the National Bureau of Standards and are obtainable from the Superintendent of Documents, Washington, D. C., for 10 and 20 cents, respectively. The third publication is obtainable direct from the National Bureau of Standards, Washington, D. C. Additional information on fire resistance of various structural members is being developed through research at the National Bureau of Standards. Inquiries concerning this should be addressed to the Bureau at Washington, D. C.

It is recommended that draft stops be placed in attic spaces whenever walls or partitions are not carried up to the under side of the roof sheathing. Such draft stops should be placed at least at every second dwelling and should have incombustible material on at least one side.

As a basis for determining whether an attic can be used for storage, it is suggested that an opening containing more than 400 square inches should be considered as making storage possible.

### Paragraph 802–1. General

It is desirable that firestopping in partitions between dwelling units should be incombustible.

### Paragraph 804. Roof Coverings

Through the courtesy of the Subcommittee on Fire Resistance Classifications of the Central Housing Committee on Research, Design, and Construction, the following information has been supplied concerning roof coverings:

#### Lists of Acceptable Roof Coverings

The general requirements of Section 804 are exemplified by the following lists of roof coverings of which a sufficient number have been tested to indicate acceptability for the different classifications. Pending the establishment of definite performance requirements for various classes of roof coverings, additional coverings not included herein can be classified by comparison under recognized tests with roof coverings hereafter classified.

*Built-up Roof Coverings.*[26] Built-up roof coverings are assumed to be applied according to accepted good practice. The minimum total combined weight of bonding and coating materials required per 100 sq ft of roof surface, for coverings nailed to deck and coverings held in place by cementing material applied directly to deck, are given below. In the case of roof coverings nailed to deck, weights are based on designs which permit the least number of felt layers to be bonded with cementing material. Weights of felt given below are minima.

Roofs surfaced with gravel or slag require not less than 400 lb of roofing gravel or crushed stone or 300 lb of crushed slag per 100 sq ft of roof surface.

Class 1. *Built-up roof coverings*

| Kinds of built-up roof coverings | Minimum weight of cementing material per 100 sq ft | |
|---|---|---|
| | Nailed to deck | Cemented to deck |
| | *lb* | *lb* |
| Asbestos-felt saturated with asphalt, bonded and surfaced with asphalt cement: | | |
| (1) 4 layers of 14-lb felt (18-lb if coated) | 60 | 110 |
| (2) 2 layers of 28-lb felt (each of 2-ply 14-lb felt) | 40 | 70 |
| (3) 1 layer of 35-lb felt (55-lb if coated) and 2 layers of 14-lb felt (18-lb if coated) | 60 | 90 |
| (4) 3 layers of 14-lb felt (18-lb if coated). Limited to incombustible decks | 40 | 90 |
| (5) 2 layers of 35-lb felt (55-lb if coated). Limited to incombustible decks | 40 | 70 |
| Rag-felt saturated with asphalt, bonded with asphalt cement and surfaced with gravel or slag on asphalt cement: | | |
| (1) 4 layers of 14-lb felt | 100 | 150 |
| (2) 1 layer of 28-lb felt and 2 layers of 14-lb felt | 100 | 130 |
| (3) 1 layer of 14-lb felt and 2 layers of 20-lb or heavier cap or base sheets | 100 | 130 |
| (4) 3 layers of 20-lb or heavier cap or base sheets | 100 | 130 |
| (5) 3 layers of 14-lb felt. Limited to incombustible decks | 80 | 130 |
| Asbestos-felt saturated with asphalt and rag-felt saturated with asphalt bonded and surfaced with asphalt cement: | | |
| (1) 1 layer of 28-lb rag-felt and 2 layers of 14-lb asbestos felt (18-lb if coated). Limited to incombustible decks | 60 | 90 |
| Asbestos-felt or rag-felt saturated with tar, bonded with tar and surfaced with gravel or slag on tar: | | |
| (1) 4 layers of 14-lb felt | 120 | 185 |
| (2) 3 layers of 14-lb felt. Limited to incombustible decks | 95 | 160 |
| Rag-felt saturated with asphalt, bonded with asphalt cement and surfaced with ½-in. asphalt impregnated fibrous board applied with asphalt mastic: | | |
| (1) 3 layers of 14-lb felt or other class built-up roofing | 40 | 90 |

[26] Built-up roof coverings are those which are composed of materials which are bonded together into layers as they are put in place on the roof.

Class 2. *Built-up roof coverings*

| Kinds of huilt-up roof coverings | Minimum weight of cementing material per 100 sq ft | |
|---|---|---|
| | Nailed to deck | Cemented to deck |
| | *lb* | *lb* |
| Ashestos-felt saturated with asphalt, bonded and surfaced with asphalt cement: | | |
| (1) 3 layers of 14-lh felt (18-lb if coated) | 40 | 90 |
| (2) 2 layers of 35-lh felt (55-lb if coated) | 40 | 70 |
| (3) 1 layer of 35-lb felt (55-lh if coated) and 1 layer of 14-lh felt (18-lh if coated) | 40 | 70 |
| Rag-felt saturated with asphalt, honded with asphalt cement and surfaced with gravel or slag on asphalt cement: | | |
| (1) 3 layers of 14-lh felt | 80 | 130 |
| (2) 2 layers of 30-lh or heavier cap or hase sheets | 80 | 110 |
| Asbestos-felt or rag-felt saturated with tar, honded with tar and surfaced with gravel or slag on tar: | | |
| (1) 3 layers of 14-lb felt | 95 | 160 |

Class 3. *Built-up roof coverings*

| Kinds of built-up roof coverings | Minimum weight of cementing material per 100 sq ft | |
|---|---|---|
| | Nailed to deck | Cemented to deck |
| | *lb* | *lb* |
| Rag-felt saturated with asphalt, honded and surfaced with asphalt cement: | | |
| (1) 3 layers of 14-lh felt | 40 | 90 |
| (2) 1 layer of 28-lh felt and 1 layer of 14-lh felt | 40 | 70 |
| (3) 2 layers of 20-lb or heavier cap or hase sheets | 40 | 70 |
| (4) 2 layers of 14-lh felt and 1 layer 14-lb or heavier cap or base sheet | 40 | 90 |

*Prepared Roof Coverings.*[27] Prepared roof coverings are assumed to be applied according to accepted good practice. Where rag felt is indicated, asbestos felt of equal weight can be substituted.

From the standpoint of relative effectiveness of the different types of wood roof sheathing, the tongue-and-groove boards gave the best results in the brand and flame tests and the square-edge sheathing with boards spaced about ¼ inch apart were indicated as better than slat decks of 3-inch strips spaced 5 or more inches on centers. Accordingly for classifications based on slat-supporting construction, square-edge or tongue-and-groove sheathing can be substituted and the latter can be substituted for the square-edge sheathing.

By "end lap" is meant the overlapping length of two units, one placed over the other. Head lap is the distance that the lower of three superimposed units overlaps the upper unit.

Where the coverings are applied over concrete or other masonry roof slabs of 1 inch or greater thickness, the thickness of the roof covering is not a consideration as far as fire resistance is concerned.

[27] Roof coverings which have heen preassembled or formed into final shape hefore heing installed are known as prepared roof coverings.

Class 1. Prepared roof coverings

Brick 2¼ inch thick.

Metal-reinforced portland cement concrete 1 inch thick.

Concrete tile or clay floor tile or deck tile 1 inch thick.

Flat or French type clay or concrete roof tile, ⅜ inch thick with 1½-inch or more end lap and head lock spacing body of tile ½ inch or more above roof sheathing, with underlay of asphalt-saturated rag-felt in one or two layers of total weight not less than 24 lb per 100 sq ft or one layer of asphalt-saturated asbestos-felt weighing not less than 14 lb per 100 sq ft.

Clay or concrete roof tile, Spanish or Mission pattern, 7/16 inch thick, 3-inch end lap, same underlay as above.

Slate 3/16 inch thick, 3-inch head lap.

Cement-asbestos shingles laid American method, 3/16-inch or greater average thickness, 2-inch head lap.

Asphalt-saturated asbestos sheet roofing, 4-ply with an unsaturated asbestos top sheet, weight not less than 80 lb per 100 sq ft of roof surface, laid in single thickness with 2-inch end lap and side edges butted, with 6-inch wide strip beneath.

Class 2. Prepared roof coverings

Cement-asbestos shingles of 3/16-inch or greater thickness laid with not less than 2-inch side, end, or combined side and end lap, according to the French, Dutch, or Scotch method, with underlay of asphalt-saturated rag-felt in one or two layers of total weight not less than 24 lb per 100 sq ft or one layer of asphalt-saturated asbestos-felt weighing not less than 14 lb per 100 sq ft.

Asphalt-asbestos smooth-surfaced sheet roofing 3-ply laid in single thickness, weight not less than 60 lb per 100 sq ft of roof surface with 2-inch end lap and side edges butted, with 6-inch wide strip beneath.

Asphalt-asbestos felt smooth-surfaced sheet roofing, 3-ply with an unsaturated asbestos top sheet, weight not less than 55 lb per 100 sq ft of roof surface laid in single thickness with 2-inch or more end and side laps.

Asphalt-asbestos felt shingles made of asbestos felt saturated and coated with asphalt, surfaced with mineral granules and weighing not less than 80 lb per 108 sq ft and as laid on the roof with 2-inch or more head lap, not less than 180 lb per 100 sq ft of roof surface.

Asphalt mastic shingles composed of asphalt and fibrous and granular materials of which not less than 45 percent by weight is incombustible, laid with not less than 2-inch head lap, total weight not less than 425 lb per 100 sq ft of roof surface.

Copper, galvanized-iron, or tin-coated iron standing-seam or flat-seam sheet roofings, underlaid with 14-pound saturated or unsaturated asbestos felt or asphalt-saturated rag-felt in one or two layers of total weight not less than 24 lb per 100 sq ft.

Copper or galvanized-iron tile or shingle pattern roofings with same underlay as above.

Class 3. Prepared roof coverings

Copper, galvanized-iron, or tin-coated standing-seam or flat-seam sheet roofing either without underlay or with underlay of rosin-sized paper.

Copper or galvanized-iron tile or shingle pattern roofings without underlay or with underlay of rosin-sized paper.

Asphalt rag-felt individual or strip shingles made of rag-felt saturated and coated with asphalt, surfaced with mineral granules and weighing not less than 80 lb per 108 sq ft and as laid on the roof with 2-inch or more head lap, not less than 180 lb per 100 sq ft of roof surface.

Asphalt-asbestos felt roll roofing surfaced with mineral granules and laid in single thickness with 2-inch or more side and end laps, weight not less than 85 lb per 100 sq ft of roof surface.

Asphalt-asbestos felt smooth-surfaced sheet or roll roofing laid in single thickness with 2-inch or more end and side lap, weight not less than 50 lb per 100 sq ft of roof surface.

Zinc sheet or shingle roofings with underlay of 24-pound asphalt-saturated rag-felt in one or two thicknesses or 14-pound unsaturated or asphalt-saturated asbestos-felt.

Wood shingles with butt thickness not less than ⅜ inch laid with not less than 6-inch head lap, coated on bottom with asphalt emulsion weighing not less than 4 lb per 100 sq ft of roof surface, except for upper 2 inches, and on top and three edges with asphalt weighing not less than 60 lb per 100 sq ft of roof surface, into which are embedded granules of crushed slate weighing not less than 116 lb per 100 sq ft of roof surface. Shingles are to be laid over slat or close ¾-inch wood sheathing.

Class 4. Roof coverings

Asphalt rag-felt mineral-surfaced roll roofing laid in single thickness with 2-inch or more end and side laps, weight not less than 75 lb per 100 sq ft of roof surface.

Asphalt rag-felt smooth-surfaced roll roofing laid in single thickness with 2-inch or more end and side laps, weight not less than 35 lb per 100 sq ft of roof surface.

Wood shingles of not less than ⅜-inch butt thickness chemically treated under pressure with double treatment of sodium borate and zinc chloride with evacuation and drying between treatments laid with 6-inch or more head lap.

Edge-grain red cedar, redwood, and No. 1 pine shingles 7/16-inch butt thickness, 18 inches long, laid with 5-inch weather exposure on ¾-inch square-edge wood sheathing with boards spaced not more than ¼ inch apart.

Edge-grain red cedar and redwood shingles, ⅜-inch butt thickness, 16 inches long laid with 5-inch weather exposure on ¾-inch tongue-and-groove wood sheathing.

Edge-grain red cedar and redwood shingles, ⅜-inch butt thickness, 16 inches long laid with 5-inch weather exposure on ¾-inch square-edge wood sheathing with boards spaced not more than ¼ inch apart and asphalt- or tar-saturated rag-felt between shingles and sheathing.

Wood shingles of any species ⅜-inch or greater butt thickness, 16-inch or greater length, laid with not less than 6-inch head lap on ¾-inch square-edge or tongue-and-groove wood sheathing, space between boards not more than ¼ inch and underlay between boards and shingles of asphalt-saturated rag-felt in one or two layers, weighing not less than 24 lb per 100 sq ft or asphalt-saturated asbestos-felt weighing not less than 14 lb per 100 sq ft.

Red cedar, redwood, or No. 1 pine shingles, butt thickness not less than ⅜ inch, 16-inch or greater length, laid with not less than 6-inch head lap on ¾-inch square-edge or tongue-and-groove wood sheathing, space between boards not more than ¼ inch, shingles before application to be dipped to within 2 inches of the top in mineral oxide paint thinned so the weight of pigment is not less than 30 percent of the weight of the prepared paint, and a brush coat of the unthinned paint applied over the exposed length after application on the roof.

Class 5. Roof coverings

Wood shingle constructions not included under Class 4.

Paragraph 900. General

In localities where weather conditions make it justifiable, a provision might well be included to the effect that appliances capable of heating habitable rooms to a temperature of 70° Fahrenheit at all times shall be provided.

Paragraph 901–12. Special Types of Chimneys

Tests are now in process at the National Bureau of Standards on various special types of chimneys. It is expected that the information obtained from these tests will provide a basis for determining what types are acceptable.

Paragraph 903. Fireplaces

It is important that a fireplace should have correct dimensions, not only for proper functioning as a heat appliance but also to guard against hazards from sparks thrown out by down drafts. The matter of correct dimensions is discussed at some length on pages 35–43, inclusive, of Farmers' Bulletin 1889 Fireplaces and Chimneys, issued by the United States Department of Agriculture, dated December 1941. It is recommended that fireplace dimensions be made to conform to the recommendations contained in that document.

Paragraph 908. Mechanical Circulation Warm-Air Systems

The standards mentioned in Section 908–1 are obtainable from the National Board of Fire Underwriters, 85 John Street, New York, N. Y.

The Practical Code for the Design and Installation of Mechanical Warm Air Heating Systems, applicable only to the average small installation, and the Technical Code for the Design and Installation of Mechanical

Warm Air Heating Systems, both issued in June 1940 by the National Warm Air Heating and Air Conditioning Association, are obtainable from the association, 5 East Long Street, Columbus, Ohio, for 25 and 50 cents, respectively.

### Paragraph 910. Appliances

The requirements mentioned in Section 910–1 (a) are obtainable from the American Gas Association, 420 Lexington Avenue, New York, N. Y., for 40 and 50 cents, respectively.

NBFU Pamphlet No. 58, containing the standards mentioned in Section 910–1 (f), is obtainable from the National Board of Fire Underwriters, 85 John Street, New York, N. Y.

The code mentioned in Section 910–3 is obtainable from the American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y., for 75 cents, with a 20-percent discount to ASME members.

Information concerning Commercial Standards may be obtained from the National Bureau of Standards, Washington, D. C. The Commercial Standards mentioned in Section 910–2 and in Section 910–4 are obtainable from the Superintendent of Documents, Washington, D. C., for 5 cents each.

### Paragraph 1000. Safeguards Against Accidents

For further information on measures tending to reduce hazards in and about dwellings, see Principle 29, of Basic Principles of Healthful Housing, Second Edition, May 1939. This report of the Committee on the Hygiene of Housing of the American Public Health Association, 1790 Broadway, New York, N. Y., is obtainable from the association for 25 cents.

### Paragraph 1101. National Electrical Code

The National Electrical Code is obtainable from the National Board of Fire Underwriters, 85 John Street, New York, N. Y., for 5 cents.

### Paragraph 1201. Plumbing Standards

Emergency Plumbing Standards for Defense Housing is obtainable from the National Housing Agency, Washington, D. C.

### Paragraph 1202. Sanitary Fixtures

For further information on sanitary fixtures, see Part VIII of Sanitation Code for State or Local Adoption, May 1941, obtainable from the United States Public Health Service, Washington, D. C.

---

### Rats

In localities where it is established that rats exist in sufficient numbers to constitute a health hazard, code requirements concerning ratproofing are justified. For information on this subject see Principle 21, of Basic Requirements for Healthful Housing, Second Edition, May 1939, a report by the Committee on the Hygiene of Housing of the American Public Health Association, 1790 Broadway, New York, N. Y. The report is obtainable from the association for 25 cents.

The Rat and Ratproof Construction of Buildings, Supplement No. 131 to the Public Health Reports, issued by the United States Public Health Service and obtainable, for 15 cents, from the Superintendent of Documents, Washington, D. C., includes specifications and a Model Ratproofing Ordinance.

### Noise

Although no specific requirements regarding noise are contained in the Code, it is recognized that measures to exclude or reduce excessive noise are desirable. Such measures are discussed in Principle 7, of Basic Principles for Healthful Housing, Second Edition, May 1939, a report by the Committee on Hygiene of Housing, American Public Health Association, 1790 Broadway, New York, N. Y. The report is obtainable from the association for 25 cents. Ultimately, these measures may find their way into mandatory requirements, but for the present they are cited merely as good practice.

# INDEX

WASHINGTON, April 23, 1942.

## BUILDING MATERIALS AND STRUCTURES REPORTS

[Continued from cover page II]

BMS32 Structural Properties of Two Brick-Concrete-Block Wall Constructions and a Concrete-Block Wall Construction Sponsored by the National Concrete Masonry Association 10¢
BMS33 Plastic Calking Materials 10¢
BMS34 Performance Test of Floor Coverings for Use in Low-Cost Housing: Part 1 10¢
BMS35 Stability of Sheathing Papers as Determined by Accelerated Aging 10¢
BMS36 Structural Properties of Wood-Frame Wall, Partition, Floor, and Roof Constructions with "Red-Stripe" Lath Sponsored by The Weston Paper and Manufacturing Co 10¢
BMS37 Structural Properties of "Palisade Homes" Constructions for Walls, Partitions, and Floors, Sponsored by Palisade Homes 10¢
BMS38 Structural Properties of Two "Dunstone" Wall Constructions Sponsored by the W. E. Dunn Manufacturing Co 10¢
BMS39 Structural Properties of a Wall Construction of "Pfeifer Units" Sponsored by the Wisconsin Units Co 10¢
BMS40 Structural Properties of a Wall Construction of "Knap Concrete Wall Units" Sponsored by Knap America, Inc 10¢
BMS41 Effect of Heating and Cooling on the Permeability of Masonry Walls 10¢
BMS42 Structural Properties of Wood-Frame Wall and Partition Constructions with "Celotex" Insulating Boards Sponsored by The Celotex Corporation 15¢
BMS43 Performance Test of Floor Coverings for Use in Low-Cost Housing: Part 2 10¢
BMS44 Surface Treatment of Steel Prior to Painting 10¢
BMS45 Air Infiltration Through Windows 10¢
BMS46 Structural Properties of "Scot-Bilt" Prefabricated Sheet-Steel Constructions for Walls, Floors, and Roofs Sponsored by The Globe-Wernicke Co 10¢
BMS47 Structural Properties of Prefabricated Wood-Frame Constructions for Walls, Partitions, and Floors Sponsored by American Houses, Inc 10¢
BMS48 Structural Properties of "Precision-Built" Frame Wall and Partition Constructions Sponsored by the Homasote Co 10¢
BMS49 Metallic Roofing for Low-Cost House Construction 10¢
BMS50 Stability of Fiber Building Boards as Determined by Accelerated Aging 10¢
BMS51 Structural Properties of "Tilecrete Type A" Floor Construction Sponsored by the Tilecrete Co 10¢
BMS52 Effect of Ceiling Insulation Upon Summer Comfort 10¢
BMS53 Structural Properties of a Masonry Wall Construction of "Munlock Dry Wall Brick" Sponsored by the Munlock Engineering Co 10¢
BMS54 Effect of Soot on the Rating of an Oil-Fired Heating Boiler 10¢
BMS55 Effects of Wetting and Drying on the Permeability of Masonry Walls 10¢
BMS56 A Survey of Humidities in Residences 10¢
BMS57 Roofing in the United States—Results of a Questionnaire 10¢
BMS58 Strength of Soft-Soldered Joints in Copper Tubing 10¢
BMS59 Properties of Adhesives for Floor Coverings 10¢
BMS60 Strength, Absorption, and Resistance to Laboratory Freezing and Thawing of Building Bricks Produced in the United States 15¢
BMS61 Structural Properties of Two Nonreinforced Monolithic Concrete Wall Constructions 10¢
BMS62 Structural Properties of a Precast Joist Concrete Floor Construction Sponsored by the Portland Cement Association 10¢
BMS63 Moisture Condensation in Building Walls 10¢
BMS64 Solar Heating of Various Surfaces 10¢
BMS65 Methods of Estimating Loads in Plumbing Systems 10¢
BMS66 Plumbing Manual 20¢
BMS67 Structural Properties of "Mu-Steel" Prefabricated Sheet-Steel Constructions for Walls, Partitions, Floors, and Roofs Sponsored by Herman A. Mugler 15¢
BMS68 Performance Test of Floor Coverings for Use in Low-Cost Housing: Part 3 15¢
BMS69 Stability of Fiber Sheathing Boards as Determined by Accelerated Aging 10¢
BMS70 Asphalt-Prepared Roll Roofings and Shingles 15¢
BMS71 Fire Tests of Wood- and Metal-Framed Partitions 10¢
BMS72 Structural Properties of "Precision-Built, Jr." Prefabricated Wood-Frame Wall Construction Sponsored by the Homasote Co 10¢
BMS73 Indentation Characteristics of Floor Coverings 10¢
BMS74 Structural and Heat-Transfer Properties of "U. S. S. Panelbilt" Prefabricated Sheet-Steel Constructions for Walls, Partitions, and Roofs Sponsored by the Tennessee Coal, Iron & Railroad Co 15¢
BMS75 Survey of Roofing Materials in the North Central States 15¢
BMS76 Effect of Outdoor Exposure on the Water Permeability of Masonry Walls 15¢
BMS77 Properties and Performance of Fiber Tile Boards 10¢
BMS78 Structural, Heat-Transfer, and Water-Permeability Properties of Five Earth-Wall Constructions 20¢
BMS79 Water-Distributing Systems for Buildings 15¢
BMS80 Performance Test of Floor Coverings for Use in Low-Cost Housing: Part 4 15¢
BMS81 Field Inspectors' Check List for Building Constructions (cloth cover, 5 x 7½ inches) 20¢
BMS82 Water Permeability of Walls Built of Masonry Units 20¢

[List continued on cover page IV]

## BUILDING MATERIALS AND STRUCTURES REPORTS

[Continued from cover page III]

| | | |
|---|---|---|
| BMS83 | Strength of Sleeve Joints in Copper Tubing Made With Various Lead-Base Solders | 10¢ |
| BMS84 | Survey of Roofing Materials in the South Central States | 15¢ |
| BMS85 | Dimensional Changes of Floor Coverings with Changes of Relative Humidity and Temperature | 10¢ |
| BMS86 | Structural, Heat-Transfer, and Water-Permeability Properties of "Speedbrik" Wall Construction Sponsored by the General Shale Products Corporation | 15¢ |
| BMS87 | A Method for Developing Specifications for Building Construction | 10¢ |
| BMS88 | Recommended Building Code Requirements for New Dwelling Construction With Special Reference to War Housing | 20¢ |
| BMS89 | Structural Properties of "Precision-Built, Jr." (Second Construction) Prefabricated Wood-Frame Wall Construction Sponsored by the Homasote Co. | 15¢ |
| BMS90 | Structural Properties of "PHC" Prefabricated Wood-Frame Constructions for Walls, Floors, and Roofs Sponsored by the PHC Housing Corporation | 15¢ |
| BMS91 | A Glossary of Housing Terms | 15¢ |