

ARTICLE 8. MATERIALS, LOADS AND STRESSES

Sub-Article 1. Quality of Materials

GROUP 1

Quality of Masonry Materials

(7.1.1). §C26-305.0 General.-Masonry materials when delivered for use shall comply with the requirements of this title and the rules of the board.

(7.1.1.1). §C26-306.0 Distinguishing Marks on Masonry Units.-

a. Hollow masonry units and solid building blocks shall bear the distinguishing mark of the manufacturer. Such marks shall be as approved by the board to make easily possible the identification load bearing units. The board shall, immediately upon approval of an identification mark, forward to the Department of Housing and Buildings six certified copies of each approved identification mark.

b. A certified copy of each such mark shall be placed on file with the superintendent before the materials bearing such mark may be used.

(7.1.1.2.1). §C26-307.0 Solid Clay Units.-

a. Brick.-

1. All brick when delivered for use shall comply with the standard specifications of the A.S.T.M., D., C62-30 for "B" brick.

2. Second-hand brick may be used subject to the approval of the superintendent as to condition and quality, but in all cases such brick shall be thoroughly cleaned and be free from mortar, and shall be whole and good, hard, well-burnt brick. Light, hard brick may be used when required as a filler in walls of frame construction.

(7.1.1.2.2). b. Other Solid Clay Units.-Other solid structural units of clay shall meet the strength requirements of the standard specifications of the A.S.T.M., D., C62-30 for "U" brick, when delivered for use.

(7.1.1.3). §C26-308.0 Structural Clay Tile.-

a. Structural clay tile for bearing walls or for walls wholly or in part exposed to the weather shall at least comply with the standard specifications of the A.S.T.M., D., C34-36 for LBX tile.

b. When used in partitions, fire-proofing, furring, or exterior panel walls in accordance with section C26-446.0, structural clay tile which is not directly exposed to the weather shall comply with the standard specifications of the A.S.T.M., D., C56-41, and shall have exterior shells of at least five-eighths of an inch in over-all thickness and webs of at least one-half of an inch in over-all thickness.

(7.1.1.4). §C26-309.0 Solid or Hollow Concrete Building Block or Tile.-

a. Hollow concrete block or tile when delivered for use shall have a minimum ultimate compressive strength of seven hundred pounds per square inch of gross area tested as laid in the wall.

b. Solid concrete building block when delivered for use shall have a minimum ultimate compressive strength of fifteen hundred pounds per square inch tested as laid in the wall.

c. Such block or tile shall comply with the following requirements for general properties under visual inspection:

1. They shall be sound, of compact structure, reasonably uniform in shape and free from cracks, warpage, or foreign substances which would affect their serviceability or strength.

2. If cinders form part or all of the aggregate, the cinders may contain a maximum of thirty-five percent by weight of uncombined carbon and a maximum of one and one-half percent by weight of sulphur.

d. When used in partitions, fireproofing, furring, or exterior panel walls in accordance with section C26-446.0, solid or hollow concrete building block or tile which is not directly exposed to the weather and which has a minimum ultimate compressive strength of three hundred pounds per square inch of gross area tested as laid in the wall may be used. Hollow concrete blocks for panel walls where such blocks are not directly exposed to the weather shall comply with the standard specifications of the A.S.T.M., D., C129-39.

(7.1.1.5). §C26-310.0 Gypsum Block or Tile.-Gypsum block or tile shall comply with the standard specifications of the A.S.T.M., D., C52-41, and may contain a maximum of twelve and one-half percent by weight of combustible matter, measured dry.

(7.1.1.6). §C26-311.0 Repealed December, 1962.

(7.1.1.7.1). §C26-312.0 Mortar and Other Concrete Materials.-

a. Quick Lime-Quick lime shall comply with the standard specifications of the A.S.T.M., D., C5-34 T.

(7.1.1.7.2). b. Hydrated Lime.-Hydrated lime shall comply with the standard specifications of the A.S.T.M., D., C6-31.

(7.1.1.7.3). c. Cement.-

1. Cement shall comply with the standard specifications of the A.S.T.M: C150-62 for Portland cement or A.S.T.M. C175-61 for air entraining Portland cement.

2. The use of cements of other types which are approved by the board and are used in accordance with the rules of the board governing their use shall be permitted.

(7.1.1.7.4). d. Gypsum.-Gypsum shall comply with the standard specifications of the A.S.T.M., D., C22-41.

(7.1.1.7.5). e. Sand.-Sand shall be clean, sharp, coarse and siliceous, free from salt, lime, clay or other foreign materials.

(7.1.1.7.6). f. Water.-Water shall be clean, free from all organic materials, strong acids or alkalis, or shall be the water used in the city for drinking purposes.

(7.1.1.7.7). g. Concrete Aggregates.-Aggregates for concrete masonry shall comply with the requirements of section C26-315.0.

h. Perlite.-Perlite shall be clean, free from salt, lime, clay or other foreign matters.

i. Vermiculite.-Vermiculite shall be clean, free from salt, lime, clay or other foreign matters.

(7.1.1.8.1). §C26-313.0 Mortar Proportions.-

a. Measurements of Mortar Proportions.-Mortar proportions shall be measured by volume.

(7.1.1.8.2). b. Lime Mortar.

1. Lime mortar shall be composed of one part lime putty or hydrated lime and a maximum of three parts of sand.

2. Cement may replace equal volumes of lime in lime mortar, provided adequate methods of mixing are used so that the cement gauging will be uniformly distributed.

(7.1.1.8.3). c. Cement-Lime Mortar.-Cement-lime mortar shall be composed of one part cement, one part lime putty or hydrated lime and a maximum of six parts of sand.

(7.1.1.8.4). d. Cement Mortar.-Cement mortar shall be composed of one part of cement and a maximum of three parts of sand, to which may be added at most fifteen percent of the cement content in hydrated lime or lime putty. In cement mortar for panel walls the sand content may be increased to a maximum of ten parts to two of cement and one of hydrated lime.

(7.1.1.8.5). e. Maximum Proportion of Sand in Mortar.-The maximum proportion by volume of sand to cementing material in mortar to be used for masonry construction shall be three to one, except as provided in subdivision d of this section and in section C26-314.0.

(7.1.1.9). §C26-314.0 Other Mortars.-

- a. Other mortars may be used provided they comply with the following requirements and the use of each individual brand is approved in accordance with the rules of the board.
- b. Such other mortars may be used in place of cement mortars when cement mortars are not specifically required and when such other mortars have, when tested in accordance with the rules of the board, a tensile strength of at least one hundred fifty pounds per square inch at the age of twenty-eight days.
- c. Such mortars may be used in place of cement-lime mortars provided they have a tensile strength of at least one hundred twenty-five pounds per square inch at the age of twenty-eight days, when tested in accordance with the rules of the board. (L. 1942.)

(7.1.2.1). §C26-315.0 Repealed December, 1962.

(7.1.2.2). §C26-316.0 Repealed December, 1962.

(7.1.2.3). §C26-317.0 Repealed December, 1962.

(7.1.2.4). §C26-318.0 Repealed December, 1962.

(7.1.2.5). §C26-319.0 Repealed December, 1962.

GROUP 3

Quality of Materials for Iron and Steel

(7.1.3.1). §C26-320.0 Cast Iron.-Cast iron shall be of good foundry mixture, producing a clean, tough, gray iron. It shall conform to such specifications as may be promulgated by the board, or in the absence of such specifications, to the standard specifications of the A.S.T.M., D., A48-60T, for medium, gray iron castings. Castings shall be free from serious blow holes, cinder spots and cold shuts.

(7.1.3.2). §C26-321.0 Cast Steel.-Steel castings for building construction shall be made of open hearth, electric furnace, converter or crucible steel, and shall be practically free from blow holes. They shall conform to such specifications as may be promulgated by the board, or in the absence of such specifications, to the standard specifications of the A.S.T.M., D., A27-60, Grade 65-35 or A.S.T.M., D., A148-60, Grade 80-50.

(7.1.3.3). §C26-322.0 Structural Steel.-

- a. Except as provided in paragraph b and e of this section all structural steel for structures shall conform to such specifications as may be promulgated by the board, or in the absence of such specifications, to the standard specifications of the A.S.T.M., D., A6-62T, A7-60T, A36-62T, A242-60, A440-59T, and A441-60T, as to physical and chemical properties, method of manufacture, inspection, marking, tests, and other requirements. Structural steel members furnished with a specified minimum yield point, greater than 36,000 psi, shall at all times be identified by suitable marking as to type or grade. The A.S.T.M. specification designation, under which the material was obtained, shall be painted over any shop coat at the fabricator's paint before shipment to the erection site.
- b. Structural steel which is not known to conform to the requirements of paragraph a of this section as evidenced by the affidavit of the producer provided in section C26-368.0, b, or by mill test reports, or by the certification of an inspection bureau of known reputation, acceptable to the commissioner, may be erected as a structural member after the date upon which this law shall take effect, only upon the approval of, and under such conditions prescribed by the commissioner; but the working stresses in such a member shall not exceed ninety per cent of those provided in section C26-368.0 for A7-60T structural steel.
- c. Structural rivet steel shall comply with one of the following appropriate standard specifications of the A.S.T.M., D., A141-58, A195-59 or A406-59T.

d. High strength bolts, with suitable units, and washers when required, shall comply with one of the following appropriate specifications of the A.S.T.M., D., A325-61T, or A354-58T Grade BC.

C26-323.0 Use of special steels.-

a. General-Steels in addition to those listed in section C26-322.0 may be used in accordance with the rules of this board.

b. Special steel specifications.-Specifications for special steels shall be approved by the board.

c. Working stresses for special steel.-The maximum allowable working stresses for special steels shall be determined in accordance with the physical and chemical properties of the material and shall be approved by the board.

C26-324.0 Filler Metal.-

b. All mild steel electrodes shall conform to one of the classifications established by the specification, for mild steel arc-welding electrodes, 1958 edition, issued jointly by the American Society for Testing and Materials and the American Welding Society (ASTM designation A298-62T; AWS designation A5.4-62T), and shall be suitable for the condition of intended use.

c. All electrodes for the welding of steels covered by section C26-323.0 shall conform to one of the appropriate classifications established by the specification for low-alloy steel arc-welding electrodes, 1958 edition, issued jointly by the American Society for Testing and Materials and the American Welding Society (ASTM designation A316-58T; AWS designation A5.5-58T) or the specifications for corrosion, resisting chromium and chromium-nickel steel welding electrodes, 1962 edition, issued jointly by the American Society for Testing and Material, and the American Welding Society (ASTM designation A298-62T; AWS designation A5.4-62T), and shall be suitable for the conditions of intended use.

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

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

Welding equipment used to perform submerged arc-welding shall be approved by the board.

GROUP 4

Quality and Size of Lumber and Timbers

(7.1.4). §C26-325.0 Quality and Size of Lumber and Timbers.-The grades and quality of lumber and timbers used structurally shall conform to the commercial grades specified in the table of stresses contained in section C26-370.0, according to the rules specified in the table for the species and commercial grade, except that:

1. Load bearing studding shall be at least equal to the commercial grade of no. 2 common dimension. Studding that is not load bearing shall be at least equal to no. 3 common dimension.

2. Wood floor and roof beams, joists, rafters and framing lumbers shall be at least two inches in thickness, except that floor or roof beams of structures within the fire limits shall be at least three inches in thickness; the depths of beams, joists and girders shall be at most six times such thickness.

(7.1.5). §C26-325.1 Illegal Practices in the Sale or Use of Lumber for Construction Purposes Prohibited.-

- a. Any person, corporation or co-partnership who, within the city of New York shall have in the possession, or who shall place, use or affix without authorization from the owner thereof a stamp, label, trade mark, grade mark, serial number or other distinguishing mark, which stamp, label, trade mark, grade mark, serial number or mark is the property of a recognized association of lumber manufacturers or lumber grading bureau upon any lumber sold or intended to be sold, or used or intended to be used for or in the construction, repair or alteration of a building or other structure within the city of New York, or any person, corporation or co-partnership who shall knowingly sell or possess or use or prepare to use such lumber so marked for or in the construction, alteration or repair of a building or structure within the city of New York, shall be guilty of an offense punishable by a fine of not less than twenty-five dollars not more than one hundred dollars for the first offense, and by a fine of not less than one hundred dollars nor more than five hundred dollars, or by imprisonment for not more than six months, or both, for a subsequent offense.
- b. Possession of such lumber so marked, or of a colorable imitation of the principal features of a genuine stamp, label, trade mark, grade mark, serial number or mark as aforesaid, or unauthorized possession of a genuine stamp, label, trade mark, grade mark, serial number or mark as aforesaid, by any lumber dealer, builder or contractor, or by any employee, partner, or officer thereof shall be presumptive evidence of a violation of this section.

GROUP 5

Quality of Materials for Structural Aluminum

§C26-325.2 Structural aluminum.-

- a. Structural aluminum of the alloys known commercially as 6061-T6 and 6062-T6, shall conform to such specifications as may be promulgated by the board, or in the absence of such specifications, to the following specifications of the ASTM, Nos. B221 (6061 and 6062), B211 (6061), B209 (6061), B247 (6061), B210 (6061 and 6062), B241 (6061 and 6062) and B308 (6061 and 6062). Alloys 6061-T6 and 6062-T6 have the following nominal chemical composition:

Composition	Percentage by weight	
	6061-T6	6062-T6
Copper	0.25	0.25
Silicon	0.6	0.6
Magnesium	1.0	1.0
Chromium	0.25	0.06
Aluminum	97.9	98.09
Total	100.0	100.0

- b. The following shall be the lowest of the various specified minimum properties of the alloys known as 6061-T6 and 6062-T6 in kips per square inch:

Description	Stress
Tensile strength	38
Yield strength (offset 0.2%)	35

The following shall be accepted as the mechanical properties of the alloy 6061-T6 and 6062-T6:

Shear strength in kips per square inch.	24
Modulus of elasticity in tension and compression in kips per square inch.	10,000
Modulus of elasticity in shear, in kips per square inch.	3,800
Poisson's ratio.	1/3
Coefficient of expansion per degrees fahrenheit.	0.000012
Weight, in pounds per cubic inch.	0.098

Table of Alloys to be Used for Rivets

Designation before driving	Driving procedure	Designation after driving	Typical shear strength
6061-T6	Cold, as received	6061-T6	30
6061-T4	Hot, 990°F. to 1050°F	6061-T43	24

Alloys 6061-T6 and 6062-T6 may be used interchangeably.

c. The alloy known commercially as 2014-T6 shall conform to the following ASTM specifications, nos. B221-60T (2014), B235-60T (2014), B211-60T (2014), B211-60T (2014), B247-60T (2014), and B209-60T (alclad 2014), and has the following nominal chemical composition:

Composition	Percentage by weight
Copper	4.4
Silicon	0.8
Manganese	0.8
Magnesium	0.4
Aluminum	93.6
	100.0

The following shall be the lowest of the various specified minimum properties of the alloy known as 2014-T6 in kips per square inch:

Description	Stress
Tensile strength	60
Yield strength (offset 0.2%)	53

The following shall be accepted as the mechanical properties of the alloy 2014-T6:

Shear strength in kips per square inch.	41
Modulus of elasticity in tension and compression in kips per square inch.	10,000
Modulus of elasticity in shear, in kips per square inch.	4,000
Poisson's ratio.	1/3
Coefficient of expansion per degrees Fahrenheit.	0.000012
Weight, in pounds per cubic inch.	0.101

This alloy is heat treated for maximum strength and therefore cannot be welded without serious loss of strength.

Table of Alloys to be Used for Rivets

Designation before driving	Driving procedure	Designation after driving	Typical shear strength
2117-T4	Cold, as received	2117-T3	33
6061-T4	Hot, 990°F. to 1050°F	6061-T43	24

d. The alloy known commercially as 6063-T5 and T6, in the absence of specifications of the board, shall conform to the following specifications of the ASTM, Nos. B210 (6063-T6), B2221 (6063-T5 and T6), B235 (6063-T6), B241 (6063-T5 and T6).

This alloy has the following nominal chemical composition:

Composition	Percentage by weight
Silicon	0.4
Magnesium	0.7
Total other elements	1.0
Aluminum	97.9
Total	100.0

The following shall be the lowest of the various specified minimum properties of the alloy known of 6063-T5 and T6 in kips per square inch (thickness 0.500 inch and under):

Description	Stress
Tensile strength (6063-T6)	30
Yield strength (offset 0.2%) (6063-T6)	25
Tensile strength (6063-T5)	22
Yield strength (offset 0.2%) (6063-T5)	16

To the following shall be accepted as the mechanical properties of alloy 6063-T5 and T6:

Modulus of elasticity in tension and compression in kips per square inch.	10,000
Modulus of elasticity in shear, in kips per square inch.	3,800
Poisson's ratio.	1/3
Coefficient of expansion per degrees Fahrenheit.	0.000012
Weight, in pounds per cubic inch.	0.098

The following shall be accepted as the minimum strength values in ksi for alloy 6063-T5 and T6 (thickness 0.500 inch and under):

	Unaffected Parent Material		Material Affected by heat of welding
	6063-T5	6063-T6	6063-T5 & 6063-T6
Tensile strength	22	30	17 _a
Tensile yield strength	16	25	11 _b
Compressive yield strength	16	25	11 _b
Shear strength	13	19	11
Bearing strength	46	63	36
Bearing yield strength	25	40	17
Shear yield strength	9	14	6.5

- a. A.S.M.E. weld qualification test value for tensile strength across a butt weld.
- b. These are the expected minimum values of the yield strength across a butt weld, corresponding to 0.2 percent offset on a 10-inch gage length.
- e. Evidence satisfactory to the commissioner of buildings shall be submitted to the department, showing that the alloy used agrees with that specified in design.

This evidence shall be submitted prior to the issuance of a certificate of occupancy or letter of completion.

Sub-Article 2. Tests

GROUP 1

Methods of Testing Masonry Materials

(7.2.1). §C26-326.0 Methods of Testing Masonry Materials.-

a. Tests of all masonry material units shall be made in accordance with the standard methods of tests of the A.S.T.M., designations of which are as follows:

1. Solid Units-D., C67-37.
2. Hollow Units-D., C112-36.

b. Tests of concretes and all other monolithic construction shall be in accordance with the standard methods of test of the A.S.T.M., C39-61.

(7.2.2.1). §C26-327.0 Repealed December, 1962

(7.2.2.2). §C26-328.0 Repealed December, 1962

(7.2.2.3). §C26-329.0 Repealed December, 1962.

(7.2.2.4). §C26-330.0 Repealed December, 1962

GROUP 3

Tests of “Fireproofed” Wood

(7.2.3.1). §C26-331.0 Selection of “Fireproofed” Wood Test Samples.-Before any wood may be used where incombustible materials are required, the superintendent shall be notified promptly after a consignment of wood treated to render it fire-proofed is delivered at the job. Test samples shall then be selected promptly by an authorized representative of the department, from the consignment delivered. The provisions of this section shall not apply where plywood has been approved by the board of standards and appeals and certified by inspection at the factory as being in compliance with the approval of the board.

(7.2.3.2). §C26-332.0 Number of “Fireproofed” Wood Test Samples.-

a. At least one sample of sufficient size to furnish pieces for each of the three required tests shall be selected from each three thousand board feet of lumber. The material represented by a test sample shall be so handled at the structure that its relation to the test sample can be established at any time.

b. The pieces from a single test sample shall all be given the same number.

(7.2.3.3). §C26-333.0 Moisture Content of “Fireproofed” Wood Test Samples.-Samples shall be oven dried at a temperature of one hundred forty degrees Fahrenheit, so that the wood contains a maximum of eight percent of moisture, and shall then be tested.

(7.2.3.4). §C26-334.0 Methods and Procedure for Testing “Fireproofed” Wood.-

a. The required tests shall be at the expense of the owner or contractor or other interested party.

b. Tests of treated wood shall be made in the presence of a representative of the department, in accordance with the methods prescribed in this title by a properly qualified person or testing laboratory, acceptable to the superintendent, on pieces made from test samples selected by such representative. Reports on all tests shall be kept on file in the department.

c. If the tests are satisfactory, the entire consignment may be taken into the structure and used. If the tests are unsatisfactory, the entire shipment shall be condemned and shall be removed from the premises.

d. In general, acceptance shall be predicated upon the existence of a complete plant in full working order from which the material is shipped, and each shipment or, where possible, each piece shall be trade-marked in a conspicuous place so that there may be no doubt as to its identity.

(7.2.3.5). §C26-335.0 Apparatus for Testing “Fireproofed” Wood.-

a. Tests for “fireproofed” wood shall be conducted in a fume hood so regulated as to avoid any disturbance of the test flame.

b. The accuracy of the pyrometers used to determine temperatures in these tests shall be checked periodically.

(7.2.3.6). §C26-336.0 Crib Test for “Fireproofed” Wood.-A crib test for “fireproofed” wood shall be made in the following manner: Twelve test pieces each one-half of an inch square or less in cross-section and six inches long shall be built up in three layers of four samples each, spaced equidistant from each other to form a crib six inches square. The bottom of the crib shall be set six inches above a Bunsen burner and subjected to a temperature of twelve hundred degrees Fahrenheit for one minute. The material shall be unacceptable if after removal of the burner the flame persists in any piece longer than twenty seconds and the glow longer than thirty seconds.

(7.2.3.7). §C26-337.0 Timber Test for “Fireproofed” Wood.-

a. A timber test for “fireproofed” wood shall be made in the following manner: Two test pieces each three-quarters by one and one-half inches in cross-section and twelve inches long shall be laid flat, in contact, across the top of a gas crucible furnace and subjected for two minutes to a flame of seventeen hundred degrees Fahrenheit. At the expiration of that time the test pieces shall be removed from the furnace and the duration of the flame and glow recorded. The test pieces shall then be cross-cut at the point in the burned section where the unburned cross-sectional area is the least and that area shall be measured and recorded. Any piece shall be unacceptable in which the flame persists for longer than fifteen seconds and the glow for longer than twenty seconds. The unburned area of hard woods shall be at least fifty-five percent and of soft woods at least forty-five percent of the original cross-sectional area.

b. Where timber test samples of standard cross-sectional dimensions are unobtainable from the manufactured product, smaller sections shall be used in making timber tests, but if the cross-sectional area is less than the standard, the unburned area may be ignored.

c. In making this test, woods from deciduous trees, except poplar (white wood), basswood, red gum and tupelo, shall be considered hardwoods while all other woods including those specifically mentioned above shall be considered softwoods.

(7.2.3.8). §C26-338.0 Shavings Test for “Fireproofed” Wood.-

a. A shaving test for “fireproofed” wood shall be made in the following manner: A mass of shavings shall be cut fairly thick by hand plane from the test sample and placed to a depth of two inches in a metal vessel twelve inches in diameter, the bottom of which consists of a wire screen of one-half inch mesh.

b. The shavings shall be packed down moderately to reduce the air spaces. A Bunsen yellow flame shall then be placed beneath the vessel so that the flame is in contact with the shavings. After twenty-five seconds the flame shall be removed. The flame shall show a maximum height of six inches above the top of the bed of shavings and the shavings shall be consumed in five or more minutes.

(7.2.3.9). §C26-339.0 Determination of Results of “Fireproofed” Wood Tests.-The wood represented by anyone test sample shall be considered to have passed the requirements of this title if any two of the three tests, prescribed in sections C26-336.0 through C26-338.0, are satisfactory.

Sub-Article 3. Loads

GROUP 1

General Load Requirements

(7.3.1). §C26-340.0 General.-Structures and all parts thereof shall be of sufficient strength to support safely their imposed live loads in addition to their own dead load; and, in any event, all structures shall be designed to support at least the minimum live loads specified in this title; the superintendent shall have authority to fix live loads for structures not covered by the provisions of this title.

(7.3.1.1). §C26-341.0 Allowance for Partition Loads.-

a. Provision shall be made for a uniformly distributed load of twenty pounds per square foot to be added to the dead loads of floors in office and public buildings where partitions, other than light wood or metal partitions, are not definitely located in the design, and in other structures, subject to shifting of partitions without reference to arrangement of floor beams or girders; except that, in non-fireproof structures, the superintendent may reduce such added dead loads for partitions, to twelve or more pounds per square foot, where such partitions are not definitely located in the design.

b. In all cases, the added dead load provided for shall be stated on the plans filed with the superintendent. The weight of definitely located partitions shall be included in the calculation of dead loads.

(7.3.1.2). §C26-342.0 Allowance for Weight of Cinder Filling.-Cinder filling shall be assumed to weigh sixty pounds per cubic foot.

GROUP 2

Live Loads

(7.3.2.1). §C26-343.0 Live Loads to be Posted.-The live load for which each floor or part of a floor in a commercial or industrial structure is designed shall be certified by the superintendent and shall be indicated on a small scale floor plan suitably framed under glass and permanently affixed to the structure in a conspicuous location in a public hall or corridor in each floor. The maximum wheel load of any vehicle, including its load, which may be stored, or brought into the structure shall be stated on the floor load signs posted in garages. The occupants of the structure shall be responsible for keeping the actual loads within the certified limits. Where areas of the same floors are posted for use with different loads, such areas shall be separated by partitions or by such definite physical divisions as may be required by the superintendent, except in cases where the major portion of the floor loading consists of fixed, permanent equipment, and when an easily legible plan of at least one-eighth inch to the foot scale and indicating clearly the various load areas is framed under glass and posted in a conspicuous location in each story affected, partitions or other definite physical divisions shall not be required. The superintendent may require additional indication of load area boundaries by means of signs suspended from the ceiling if deemed necessary.

(7.3.2.2.1). §C26-344.0 Live Loads for Human Occupancies.-

a. Live Loads for Residences and Sleeping Quarters.-For private dwellings, multiple dwellings, bedroom floors in hotels and clubhouses, private and ward room floors in hospitals, dormitories, and for similar occupancies, including corridors, the minimum live load shall be taken as forty pounds per square foot uniformly distributed.

(7.3.2.2.2). b. Live-Loads for Office Space.-For office floors, including corridors, the minimum live load shall be taken as fifty pounds per square foot uniformly distributed.

(7.3.2.2.3.) c. Live loads for places of assembly other than theatres and halls.-For classrooms with fixed seats, including aisles and passageways between seats, for churches with fixed seats, for

reading rooms, and for classrooms not exceeding nine hundred square feet of floor area with movable seats, the minimum live load uniformly distributed shall be taken as sixty pounds per square foot, provided that such movable furniture consists, in addition to the instructor's equipment, of individual seatings with or without attached desks arranged as required under Section C26-273.0, subdivision c, paragraph 1, item (c).

(7.3.2.2.4). d. Live Loads for Theatres and Assembly Halls.-For the seating space in theatres and assembly halls with fixed seats, including the passageways between seats, except as provided in subdivision e of this section, the minimum live load shall be taken as seventy pounds per square foot uniformly distributed.

(7.3.2.2.5). e. Live Loads for Public Spaces and Congested Areas.-The minimum live load shall be taken as one hundred pounds per square foot, uniformly distributed, for corridors unless otherwise provided for in this section, and for halls, lobbies, public spaces in hotels and public structures, assembly halls without fixed seats, theatre stages, cabarets, barrooms, art galleries and museums, for the ground floors and basement of all hotels, stores, restaurants, shops and office buildings, for skating rinks, grand stands, gymnasiums, dancehalls, lodge rooms, stairways, fire escapes and exit passageways, and other spaces where groups of people are likely to assemble. This requirement shall be inapplicable to such spaces in private dwellings, for which the minimum live load shall be taken as in subdivision a of this section.

(7.3.2.3). §C26-345.0 Live Loads for Industrial or Commercial Occupancies and for Garages.-In designing floors for industrial or commercial purposes and for all garages other than those previously mentioned, the live load shall be assumed to be the maximum caused by the use which the structure or part of the structure is to serve. The following loads in pounds per square foot uniformly distributed shall be taken as the minimum live loads permissible for the occupancies listed, and loads at least equal shall be assumed for uses similar in nature to those listed in this section.

Floors to be used for:

1. The display and sale of light merchandise; incidental factory work in not more than twenty-five percent of the floor area 75
2. Factory work, wholesale stores, storage, and stack rooms in libraries 120
3. Stables 75
4. Garages for private passenger cars only 75
When there is floor area sufficient for the accommodation of two or more cars, the design of floors for such garages shall make provision for a concentrated load of two thousand pounds at anyone point.
5. Garages for all types of vehicles, other than garages used exclusively for private passenger cars, and for mixed car usage:
For floor construction 175
For beams columns and girders 120
The design of floors for such garages shall also make provision for the heaviest concentrated loads to which the floors may be subjected, but in all cases these loads shall be assumed to be at least six thousand pounds concentrated at any point.
6. Trucking spaces and driveways within the limits of a structure 175
The design of floors for such trucking spaces or driveways shall also make provision for the heaviest concentrated loads to which they may be subjected, but in all cases these loads shall be assumed as at least twelve thousand pounds concentrated at any point.

(7.3.2.4). §C26-346.0 Live Loads for Sidewalks.-The minimum live load for sidewalks shall be assumed to be three hundred pounds per square foot uniformly distributed. Driveways over sidewalks shall be designed for the heaviest concentrated loads to which they may be subjected, but in all cases these loads shall be assumed as at least twelve thousand pounds concentrated at any point.

(7.3.2.5). §C26-347.0 Roof Loads.-Roofs having a rise of three inches or less per foot of horizontal projection shall be proportioned for a vertical live load of forty pounds per square foot of horizontal projection applied to any or all slopes. With a rise of between three inches and twelve inches per foot, inclusive, a vertical live load of thirty pounds on the horizontal projection shall be assumed. If the rise exceeds twelve inches per foot, no vertical live load need be assumed, but provision shall be made for a wind force of twenty pounds per square foot of roof surface acting normal to such surface on one slope at a time.

(7.3.2.6). §C26-347.1 Roof loads for awnings, canopies, patio covers marquees and other similar structures. Awnings, canopies and patio covers, when constructed of aluminum alloy, steel or other approved structural materials, shall be so designed and constructed as to withstand a superimposed vertical live load of twenty pounds per square foot distributed uniformly over the area of the horizontal projection of the minor structural covering.

Where access for workmen is provided the structures shall be designed to support the weight of a man 250 pounds.

Marquees shall be designed for a 30 lb. per square foot live load.

(7.3.2.6). §C26-348.0 Reduction of live loads.-

a. In structures intended for storage purposes all columns, piers or walls and foundations may be designed for eighty-five percent of the full assumed live load. In structures intended for other uses the assumed live load used in designing all columns, piers or walls and foundations may be as follows:

- one hundred percent of the live load on the roof,
- eighty-five percent of the live load on the top floor,
- eighty percent of the live load on the next floor,
- seventy-five percent of the live load on the floor next below.

On each successive lower floor, there shall be a corresponding decrease in the percentage, provided that in all cases at least fifty percent of the live load shall be assumed.

b. Girder members, except in roofs and as specified in the following subdivision, carrying a designed floor load the equivalent of two hundred square feet or more of floor area may be designed for eighty-five percent of the specified live loads.

c. In designing trusses and girders which support columns and in determining the area of footings, the full dead loads plus the live loads may be taken with the reductions figured as permitted above.

GROUP 3

Wind Pressure

(7.3.3.1). §C26-349.0 General Requirements For Wind Pressure.-All structures or parts of structures, signs and other exposed structures shall be designed, in accordance with the requirements of this title and the rules of the board, to resist, in the structural frame, horizontal wind pressure from any direction.

(7.3.3.2). §C26-350.0 Wind Pressure in Structures Over One Hundred Feet in Height.-When the height of a structure is over one hundred feet, the assumed wind pressure shall be twenty pounds per square foot of exposed surface from the top of the structure down to the one-hundred-foot level.

(7.3.3.3). §C26-351.0 Wind Pressure in Structures One Hundred Feet High or Less, Narrow Structures and Special Types of Structures.-All structures one hundred feet high or less, shall be investigated as to the need for wind bracing, but, in general, wind pressure in such structures may be neglected. All structures, two hundred feet or less in height, in which the height is more than two and one-half times the least width, mill buildings, shops, roofs over auditoriums or drill sheds, and structures of similar character, shall be designed to withstand an assumed wind pressure of twenty pounds per square foot on the upper fifty percent of their height.

(7.3.3.4). §C26-352.0 Wind Pressure in Tank Towers, Stacks and Other Exposed Structures.-Tank towers, stacks and other exposed structures on the tops of buildings shall be designed to withstand an assumed wind pressure of thirty pounds per square foot of gross exposed projected area except as provided in section C26-352.1.

(7.3.3.4.1) §C26-352.1 Wind Pressure on Isolated Chimneys.-Isolated chimneys shall be designed to withstand an assumed wind pressure of thirty pounds per square foot of area. The area to be used in calculating total wind pressure shall be considered as two-thirds of the projected area for round chimneys and five-sixths of the projected area for octagonal chimneys, and the full projected area for square chimneys. The projected area shall in all cases be the diameter of the circumscribed circle multiplied by the height of the chimney, or section of chimney, under consideration.

(7.3.3.5). §C26-353.0 Stability.-The overturning moment due to wind pressure shall not exceed seventy percent of the moment of stability of the structure as measured by the dead loads in the columns, unless the structure is securely anchored to the foundation. Anchors shall be of sufficient strength to carry

safely the excess overturning moment without exceeding the working stresses prescribed in sections C26-354.0 through C26-375.0 and in sections C26-510.0 through C26-527.0.

Sub-Article 4. Allowable Working Stresses

GROUP 1

General Requirements for Allowable Working Stresses

(7.4.1). §C26-354.0 General Requirements For Allowable Working Stresses.-The allowable working stresses for all materials shall be in accordance with the requirements of this article and the rules of the board.

GROUP 2

Masonry Stresses

(7.4.2.1). §C26-355.0 Calculation of Strength of Hollow Units.-The ultimate compressive strengths of all hollow units shall be calculated on the gross cross-sectional areas, with the exception of structural clay tile for partitions, which shall conform to the requirements of section C26-308.0.

(7.4.2.2.). §C26-356.0 Working Stresses For Brick Masonry.-

a. The maximum allowable compressive stresses in brick masonry, due to combined live and dead loads, expressed in pounds per square inch of gross cross-sectional area, shall be as given in the following table:

Solid wall			Hollow walls		
Lime Mortar	Cement-lime mortar	Cement mortar	Lime Mortar	Cement-lime mortar	Cement mortar
100	250	325	50	125	150

b. When the average compressive strength of brick is in excess of forty-five hundred pounds per square inch, the stresses given above may be increased to ten percent of the average strength of the unit when laid in cement mortar or to eight and one-third percent when laid in cement-lime mortar, but the maximum allowable stress shall be five hundred pounds per square inch.

c. In the design of tall chimneys the following, shall be considered as the maximum fibre stresses based on the gross cross sectional area of the walls, constructed of perforated radial brick with perforations not to exceed thirty-three percent (33%) of gross area of the brick, applying the cantilever beam formulae:

Compression-two hundred fifty pounds per square inch.

Tension-twenty-five pounds per square inch.

For the purpose of determining the stability of a chimney, the weight of the brick masonry shall be assumed to be not more than 120 pounds per cubic foot. The weight of the lining shall not be considered when calculations are made for the compression or tension stresses in the brickwork of the chimney.

(7.4.2.3). §C26-357.0 Working Stresses For Structural Clay Tile Masonry.-

a. The maximum allowable compressive stress in masonry of structural clay tile, when laid in cement mortar with cells vertical, shall be one hundred twenty-five pounds per square inch of gross cross-sectional area; and when laid in cement-lime mortar with cells vertical, shall be one hundred pounds per square inch of gross cross-sectional area.

b. When such tile is laid in cement mortar with cells horizontal, the maximum allowable compressive stress shall be seventy pounds per square inch of gross cross-sectional area, and when

laid in cement-lime mortar with cells horizontal, the maximum allowable compressive stress shall be sixty pounds per square inch of gross cross-sectional area.

c. Hollow building units for load bearing walls or piers shall be laid either in cement or cement-lime mortar.

(7.4.2.4). §C26-358.0 Working Stresses For Concrete Block or Tile Masonry.-

a. The maximum allowable compressive stress in masonry of concrete block or tile or of solid concrete units, due to combined live and dead loads, shall be one-tenth of the ultimate compressive strength of the units prescribed in section C26-309.0, where cement mortar is used and one-twelfth where cement-lime mortar is used.

b. Concrete block or tile building units for load bearing walls or piers shall be laid in cement or cement-lime mortar.

(7.4.2.5). §C26-359.0 Requirements For Other Structural Units.-Structural units other than those specified in sections C26-307.0 through C26-310.0, shall meet the requirements of subdivision a of section C26-307.0, if classified as solid; if classified as hollow, such structural units shall meet the requirements of section C26-308.0 or section C26-309.0.

(7.4.2.6). §C26-360.0 Working Stresses For Natural Stone Masonry.-The maximum allowable compressive stresses for masonry of natural stone with dressed or cut beds, due to combined live and dead loads, expressed in pounds per square inch of gross cross-sectional area, shall be as given in the following table:

Kind	Cement-lime mortar	Cement mortar
Granite	640	800
Gneiss	600	750
Limestone	400	500
Marble	400	500
Sandstone	250	300
Bluestone	300	400

The maximum allowable compressive stress for other natural cut stone masonry and for all uncut stone masonry shall be one hundred forty pounds per square inch of gross cross-sectional area in cement mortar and one hundred ten pounds in cement-lime mortar.

(7.4.2.7). §C26-361.0 Repealed December, 1962.

(7.4.2.8). §C26-362.0 Allowable Working Stress Requirements For Other Types of Construction.-

The maximum allowable working stresses for any new masonry material or for masonry material not specified in this article, due to combined live and dead loads, shall be thirty percent of the minimum ultimate compressive strength of at least three full size wall panels, each at least nine feet high.

(7.4.3.1). §C26-363.0 Repealed December, 1962.

(7.4.3.2). §C26-364.0 Repealed December, 1962.

(7.4.3.3). §C26-365.0 Repealed December, 1962.

(7.4.3.4). §C26-366.0 Repealed December, 1962.

GROUP 4

Allowable Working Stresses for Cast Iron

(7.4.4). §C26-367.0 Allowable Working Stresses For Cast Iron.-

a. All structural members of cast iron shall be so proportioned that the sum of the maximum static stresses in pounds per square inch shall be within the following:

Tension	3,000
Shear	3,000
Bending:	
Extreme fibre compression side	16,000
Extreme fibre tension side	3,000
Compression on columns	9,000 minus 40(L/r)

b. The ratio of L/r shall at most be seventy, where L is the length is the least radius of gyration.

GROUP 5

Allowable Working Stresses for Structural and Alloy Steel

C26-368.0 Allowable working stresses for structural steel.-

a. It shall be unlawful to use special steel for structural members except in accordance with section C26-323.0a.

b. If the calculated stress in a structural steel member exceeds ninety percent of the allowable stress specified in this section, for A7-60T steel, an affidavit of the producer of the steel used in the member, certifying that the steel meets the minimum requirements for structural steel as defined in section C26-322.0a, shall be filed with the commissioner, as a condition for the issuance of the certificate of occupancy required under section C26-181.0. The calculated stresses in a structural steel member installed in a structure prior to December 13, 1948 shall not exceed ninety percent of the allowable stress specified in this section for A7-60T steel except that the compressive stress in columns, or other compression members, installed before December 13, 1948 shall be within the value

$$\frac{18,000}{1 + \frac{L^2}{18,000r^2}} \text{ but not more than}$$

15,000 pounds per square inch and, for columns, the value L/r shall not be greater than 120.

c. Except as specifically provided in this section or sections C26-517.0, C26-520.0 and C26-521.0, all components of structures shall be so proportioned that the unit stress, in pounds per square inch, shall not exceed the following values except to the extent they are rounded off in the American Institute of Steel Construction's Specification for the Design, Fabrication and Erection of Structural Steel for Buildings adopted April 17, 1963.

1. Nomenclature

The following symbols shall carry the below designated meaning when used in this section.

A _b	Nominal body area of a bolt
A _c	Actual area of effective concrete flange in composite design
A _f	Area of compression flange
A _s	Area of steel beam in composite design
A _{st}	Cross-sectional area of stiffener or pair of stiffeners
A _w	Area of girder web

C_b	Bending Coefficient dependent upon moment gradient; equal to $1.75 - 1.05 \left(\frac{M_1}{M_2} \right) + 0.3 \left(\frac{M_1}{M_2} \right)^2$
C_c	Column slenderness ratio dividing elastic and inelastic buckling; equal to $\sqrt{\frac{2\pi^2 E}{F_y}}$
C_m	Coefficient applied to bending term in interaction formula and dependent upon column curvature caused by applied moments
C_v	Ratio of "critical" web stress, according to the linear buckling theory, to the shear yield point of web material
D	Factor depending upon type of transverse stiffeners
E	Modulus of elasticity of steel (29,000,000 pounds per square inch)
E_o	Modulus of elasticity of concrete
F_a	Axial compressive stress, permitted in the absence of bending stress
F_{as}	Axial compressive stress, permitted in the absence of bending stress, for bracing and other secondary members
F_b	Bending stress permitted in the absence of axial stress
F'_b	Allowable building stress in compression flange of plate girders as reduced because of large web depth-to-thickness ratio
F'_e	Euler stress divided by factor of safety; equal to $\frac{149,000,000}{(Kl_b/r_b)^2}$
F_p	Allowable bearing stress
F_t	Allowable tensile stress
F_v	Allowable shear stress
F_y	Specified minimum yield point of the type of steel being used (pounds per square inch unless otherwise noted)
I_{tr}	Moment of inertia of transformed composite section
K	Effective length factor as determined in the American Institute of Steel Construction's Steel Construction Manual, Sixth Edition
L	Span length, in feet
L_u	Maximum unbraced length of compression flange in feet for which full bending stress is permitted
M	Moment
M_1	Smaller end moment on unbraced length of beam-column
M_2	Larger end moment on unbraced length of beam-column
M_D	Moment produced by dead load
M_L	Moment produced by live load
N	Length of bearing of applied load
P	Applied load
R	Reaction or concentrated transverse load applied to beam or girder
S_s	Section modulus of steel beam used in composite design, referred to the tension flange

S_{tr}	Section modulus of transformed composite cross-section, referred to the tension flange
T_b	Proof load of a high strength bolt
V	Statistical shear on beam
V_h	Total horizontal shear to be resisted by connectors
Y	Ratio of yield point of web steel to yield point of stiffener steel
a	Clear distance between transverse stiffeners
a'	Distance required at ends of welded partial length cover plate to develop stress
b	Effective width of concrete slab
b_f	Flange width of rolled beam or plate girder
c	Distance from neutral axis to top of concrete slab
d	Depth of beam or girder. Also diameter of roller or rocker bearing
e	Horizontal displacement, in the direction of the span, between top and bottom of simply supported beam at its ends
f_a	Computed axial stress
f_b	Computed bending stress
f'_c	Specified compression strength of concrete at 28 days
f_t	Computed tensile strength
f_v	Computed shear stress in pounds per square inch
f_{vs}	Shear between girder web and transverse stiffener, in pounds per linear inch or single stiffener or pair of stiffeners
g	Transverse spacing between fastener gage lines
h	Clear distance between flanges of a beam or girder
k	Coefficient relating linear buckling strength of a plate to its dimensions and conditions of edge support. Also distance from outer face of flange to web toe of fillet
l	Actual unbraced length, in inches
l_b	Actual unbraced length in plane of bending, in inches
n	Modular ratio; equal to E / E_c
q	Allowable horizontal shear to be resisted by a connector
r	Governing radius of gyration
r_b	Radius of gyration about axis of concurrent bending
r_y	Lesser radius of gyration
s	Spacing (pitch) between successive holes in line of stress
t	Girder or beam web thickness
t_f	Flange thickness
t_t	Thickness of thinner part joined by partial penetration groove weld
w	Length of channel shear connectors
ν	Poisson's ratio

2. Tension

(1) On the net section, except at pin holes

$$0.60F_y$$

(2) On the net section at pin holes in eye bars, pin-connected plates or built-up members

$$0.45F_y$$

3. Shear

(1) On the gross section, including beam and plate girder webs

$$0.40F_y$$

4. Compression

(1) On the gross section axially loaded compression members when Kl / r , the largest effective slenderness ratio of any unbraced segment as defined in section C26-515.0 is less than C_c .

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

Formula (1)

where

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

(2) On the gross section of axially loaded columns when Kl / r exceeds C_c

$$F_a = \frac{149,000,000}{(Kl/r)^2}$$

Formula (2)

(3) On the gross section of axially loaded bracing and secondary members, when l / r exceeds 120, and K is taken as unity

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

Formula (3)

(4) On the gross area of plate girder stiffeners

$$F_a = 0.60F_y$$

(5) On the web of rolled shapes at the fillet (crippling, see section C26-517.0a10)

$$F_a = 0.75F_y$$

5. Bending

(1) Tensions and compression on extreme fibers of laterally supported compact rolled shapes and compact built-up members having an axis of symmetry in the plane of loading.

$$F_b = 0.66F_y$$

To qualify as a compact rolled shape or built-up member, the width to thickness ratio of projecting elements of the compression flange shall not exceed $1600 / \sqrt{F_y}$, except that for rolled shapes, an upward variation of 3 percent may be tolerated. The width to thickness ratio of flange plates in box sections and flange cover plates included between longitudinal lines of rivets, high strength bolts or welds, shall not exceed $6000 / \sqrt{F_y}$. The depth to thickness ratio of the web shall not exceed $13,300 / \sqrt{F_y}$. When the compact member is subjected to combined axial load and bending, the depth to thickness ratio of the web shall not exceed $13,300 (1 - 1.43f_a/F_a) / \sqrt{F_y}$, except that it need not be less than $8,000 / \sqrt{F_y}$. Flanges of compact built-up sections shall be continuously connected to the web or webs. Such members shall be

deemed to be supported laterally when the distance between points of support of the compression flange does not exceed $2,400 b_r / \sqrt{F_y}$, nor $20,000,000 a_r / dF_y$. Beams and girders which meet the requirements of the preceding sentence and are continuous over supports or are rigidly framed to columns by means of rivets, high strength bolts or welds, may be proportioned for 9/10 of the negative moments produced by gravity loading which are maximum at points of support, provided that, for such members, the maximum positive moment shall be increased by 1/10 of the average negative moments. This reduction shall not apply to moments produced by loading on cantilevers. If the negative moment is resisted by a column rigidly framed to the beam or girder, the 1/10 reduction may be used in proportioning the column for the combined axial and bending loading, provided that the unit stress f_a , due to any concurrent axial load on the member, does not exceed $0.15F_a$.

(2) Tension and compression on extreme fibers of unsymmetrical members, except channels, supported in the region of compression stress as in section C26-368.0 c,5(1)

$$F_b = 0.60F_y$$

(3) Tension and compression on extreme fibers of box-type members whose proportions do not meet the requirements of a compact section but do conform to the provisions of section C26-515.0 j, i and 2

$$F_b = 0.60F_y$$

(4) Tension on extreme fibers of other rolled shapes, built-up members and plate girders

$$F_b = 0.60F_y$$

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

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

Formula (4)

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

Formula (5)

Where l/r is less than 40, stress reduction according to Formula (4) may be neglected. r is the radius of gyration of a tee section comprising the compression flange plus one-sixth of the web area, about an axis in the plane of the web; C_b , which can conservatively be taken as unity, is equal to

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

When the bending moment at any point within an unbraced length is larger than that at both ends of this length of the ratio M_1 / M_2 shall be taken as unity

(6) Compression on extreme fibers of channels, the value computed by Formula (5), but not more than

$$F_b = 0.60F_y$$

(7) Tension and compression on extreme fibers of pins

$$F_b = 0.90F_y$$

(8) Tension and compression on extreme fibers of rectangular bearing plates

$$F_b = 0.75F_y$$

6. Bearing (on contact area)

(1) Milled surfaces including bearing stiffeners and pins in reamed, drilled or bored holes

$$F_p = 0.90F_y$$

(2) Expansion rollers and rockers, pounds per linear inch

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

where d is the diameter of roller or rocker in inches, (3) When parts in contact have different yield points F_y shall be the smaller value.

7. Combined Stresses

(1) Members subject to both axial compression and bending stresses shall be proportioned to satisfy the following requirements:

1. When $f_a / F_a \leq 0.15$

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1.0$$

Formula (6)

2. When $f_a / F_a > 0.15$

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

Formula (7a)

and in addition, at point, braced in the plane of bending.

$$\frac{f_a}{0.6F_y} + \frac{f_b}{F_b} \leq 1.0$$

Formula (7b)

C_m = a coefficient whose value shall be as follows:

1. For compression members in frames subject to joint translation (sideway), $C_m = 0.85$.

2. For restrained compression members in frames braced against joint translation and not subject to transverse loading between their supports in the plane of bending.

$$C_m = 0.6 + 0.4 \frac{M_1}{M_2}, \text{ but not less than } 0.4$$

where M_1 / M_2 is the ratio of the smaller to larger moments at the ends of that portion of the member unbraced in the plane of bending, under consideration. M_1 / M_2 is positive when the member is bent in single curvature and negative when it is bent in reverse curvature.

3. For compression members in frames braced against joint translation in the plane of loading and subjected to transverse loading between their supports, the value of C_m may be determined by rational analysis. However, in lieu of such analysis, the following value, may be used: (a) for members whose ends are restrained, $C_m = 0.85$, (b) for members whose ends are unrestrained, $C_m = 1$.

(2) Members subject to both axial tension and bending stresses shall be proportioned to satisfy the requirements of formula (7b), of subsection (1) above when f_a and F_a are taken, respectively, as the computed and permitted bending tensile stress.

However, the computed bending compressive stress taken alone, shall not exceed the value permitted by Formulas (4) and (5).

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

For A141 rivets $F_t = 28,000 - 1.6f_v \leq 20,000$

For A195 and A406 rivets $F_t = 38,000 - 1.6f_v \leq 27,000$

For A307 bolts $F_t = 20,000 - 1.6f_v \leq 14,000$

For A325 bolts in bearing-type joints $F_t = 50,000 - 1.6f_v \leq 40,000$

For A354, Grade BC, bolts in bearing-type joints $F_t = 60,000 - 1.6f_v \leq 50,000$

where f_v , the shear stress produced by the same force, shall not exceed the value for shear given in section C26-368.0 c, 8.

For bolts used in friction-type joints, the shear stress allowed in section C26-368.0 c, 8 shall be reduced so that:

For A325 bolts $F_v \leq 15,000 (1 - f_t A_b / T_b)$

For 354, Grade BC, bolts $F_v \leq 20,000 (1 - f_t A_b / T_b)$

Where f_t is the tensile strength due to applied load and T_b is the proof load of the bolt.

8. Rivets and Bolts

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

Description of Fastener	Tension (F _t)	Shear (F _v)	
		Friction Type Connection	Bearing Type Connection
A141 hot-driven rivets	20,000		15,000
A195 and A406 hot-driven rivets	27,000		20,000
A307 bolts and threaded parts of A7 and A373 steel	14,000		10,000
Threaded parts of other steels	0.40F _y		0.30F _y
A325 bolts when threading is not excluded from shear planes	40,000	15,000	15,000
A325 bolts when threading is excluded from shear planes	40,000	15,000	22,000
A354, Grade BC, bolts when threading is not excluded from shear planes	50,000	20,000	20,000
A354, Grade BC, when threading is excluded from shear planes	50,000	20,000	24,000

(2) Allowable bearing stress on projected area of bolts in bearing-type connections and on rivets

$$F_p = 1.35F_y$$

where F_y is the yield point of the connected part.

(3) Bearing stress not restricted in friction-type connections assembled with A325 and A54 Grade BC, bolts.

9. Welds

(1) Stress in fillet, plug, and slot welds, tension stress transverse to the axis of partial penetration groove welds and shear in such welds, when made with A233 Class E60 series electrodes or by submerged arc welding Grade SAW-1 on all steels, or with A233 Class E70 series electrodes or by submerged arc welding Grade SAW-2 on A7 and A373 steels. . . . 13,600.

(2) Stress in fillet, plug, and slot welds, tension stress transverse to the axis of partial penetration groove welds and shear in such welds when made with A233 Class E70 series electrodes or by submerged arc welding Grade SAW-2 on A36, A242 and A441 steels. . . . 15,800.

(3) The full stresses allowed by section C26-368.0 c for the connected material shall apply to complete penetration groove welds stressed in tension, compression, bending, shear and bearing or in tension parallel to the axis of the weld.

d. Members and connections subject to repeated variation of stress due to moving loads.

1. Up to 10,000 Complete Stress Reversals.-The stress carrying area of members, connection material and fasteners need not be increased because of repeated variation or reversal of stress unless the maximum stress allowed by Section C26-368.0 c is expected to occur over 10,000 times in the life of the structure (10,000 is approximately equivalent to one application per day for 25 years).

2. 10,000 to 100,000 Cycles of Maximum Load.-Members, connection material and fasteners (except high strength bolt in friction-type joints) subject to more than 10,000 but not over 100,000 applications of maximum design loading shall be proportioned, at unit stresses allowed in section C26-368.0 c for the kind of steel and fasteners used, to support the algebraic difference (tensile stress is designated as positive and compression stress as negative) of the maximum computed stress and two-thirds of the minimum computed stress, but the stress-carrying area shall not be less than that required in proportioning the member, connection material and fasteners to support either the maximum or minimum computed stress at the values allowed in section C26-368.0 c for the kind of steel and fasteners used (100,000 is approximately equivalent to ten applications per day for 25 years).

3. 100,000 to 2,000,000 Cycles of Maximum Load.-Members, connection material and fasteners (except high tensile strength bolts in friction-type joints) subject to more than 100,000 but not more than 2,000,000 applications of maximum design loading shall be proportioned at unit stresses allowed in section C26-368.0 c for A7 steel, A141 rivet steel, and E60 series and submerged arc Grade SAW-1 welds to support the algebraic difference of the maximum computed stress and 2/3 of the minimum computed stress, but the stress-carrying area shall not be less than that required in proportioning the member, connection material and fasteners to support either the maximum or minimum computed stress at the values allowed in section C26-368.0 c for the kind of steel and fasteners used (2,000,000 is approximately equivalent to 200 applications per day for 25 years).

4. Over 2,000,000 Cycles of Maximum Load.-Members, connection material and fasteners (except high strength bolts in friction-type joints) subject to more than 2,000,000 applications of maximum design loading shall be proportioned at two-thirds of the unit stress allowed in section C26-368.0 c for A7 steel, A141 rivet steel, and E60 series and submerged arc Grade SAW-1 welds to support the algebraic difference of the maximum computed stress and three-quarters of the minimum computed stress, but the stress-carrying area shall not be less than that required in proportioning the member, connection material and fastener to support either the maximum or

minimum computer stress at the values allowed in section C26-368.0 c for the kind of steel and fasteners used.

5. Details.-Members, subject to the provisions of section C26-368.0 d2, d3, and d4 shall have no sharp notches, sharp copes or attachment of clips, brackets or similar details, at locations where the stress exceeds 75 percent of that allowed in this section.

6. High Strength Bolted Connections.-High strength bolts in friction-type joints shall be proportioned at the unit stresses allowed in section C26-368.0 c7 and 8 to resist the largest static stress on the joint produced by any single application of the design loads.

GROUP 6

Allowable Working Stresses for Cast Steel

C26-369.0 Allowable Working Stresses for Cast Steel and Steel Forgings.-All structural members of cast or forged steel shall be so proportioned that the sum of the maximum unit stresses in pounds per square inch shall not be more than the applicable allowable stresses permitted for structural steel under section C26-368.0 c.

GROUP 7

Allowable Working Stresses of Lumber and Timber

§C26-370.0 General-

- a. The quality and design of wood members and their fastenings used for load supporting purposes shall conform to the standards herein after specified.
- b. All members shall be framed, anchored, tied and braced so as to develop the strength and rigidity necessary for the purposes for which they are used.
- c. Preparation, fabrication and installation of wood members and the glues, connectors and mechanical devices for the fastening thereof, shall conform to good engineering practices.
- d. Except as otherwise specifically provided in this code, the "National Design Specification for Stress-grade Lumber and its Fastenings," National Lumber Manufacturers Association, 1944, Revised 1953, shall be accepted as good engineering practice covering design with and use of stress-grade lumber, of glued laminated lumber and of their fastenings.
- e. All lumber and timber used as structural members of any structure and the studs of bearing partitions and non-bearing partitions of any structure, shall bear the official mark and trade mark, or such other authentication as may be approved by the superintendent, of the association under whose grade rules such lumber or timber was manufactured, or representative of such independent inspection agencies that have been certified by the Board of Review of the American Lumber Standards Committee and approved by the commissioner. The official grade marks and trade marks or other authentication acceptable to the superintendent shall be placed upon the lumber before it is delivered to the site where it is to be used. Structural lumber or studs of partitions that do not bear such marks shall not be placed upon a site of a building under construction or alteration and shall not be placed within such buildings.

§C26-370.1. Definitions.-

- a. "Nominal size lumber" is the commercial size designation of width, and depth, in standard lumber grades, somewhat larger than the standard net size of dressed lumber.
- b. "Stress grade lumber" is a lumber grade defined in such terms that a definite working stress may be assigned to it.
- c. "Structural glued laminated lumber" shall mean any member comprising an assembly of laminations of lumber in which the grain of all laminations is approximately parallel longitudinally

and in which the laminations are bonded with adhesives and which conforms to the standards applicable thereto.

d. "National Design Specification for Stress-grade Lumber and its Fastenings" shall mean the design specifications for stress grade lumber and its fastening recommended by the National Lumber Manufacturers Association, as established in 1944 and as revised in 1953.

§C26-370.2 Sizes of Structural Members.-

a. Wood structural members shall be of sufficient size to carry the dead and required live loads without exceeding the allowable working stresses hereinafter specified.

b. Minimum sizes of wood members required by this code refer to nominal sizes. The dressed sizes established for sawn lumber in American lumber standards, SPR 16-53, and for structural glued laminated lumber in the national design specification for stress-grade lumber and its fastenings shall be accepted as the minimum net sizes conforming to nominal sizes. Computations to determine the required sizes of members shall be based on their actual sizes and not the nominal sizes. Nominal sizes may be shown on the plans except that if rough sizes or dressed sizes other than those provided in the aforementioned standards are to be used, the actual sizes shall be shown on the plans.

c. Where structures are designed for use of stress-grade lumber, or structural glued laminated lumber, the sizes and the allowable unit stress and the species and the grade shall be shown on the plans.

§C26-370.3 Allowable Stresses.-

a. Except as hereinafter provided, induced stresses shall not exceed the allowable working stresses in pounds per square inch for the respective species and stress-grades of sawn lumber given in the following tables; provided further, that other grades may be approved, and the allowable stresses therefor shall be established by the superintendent in accordance with the principles set forth in the national design specification for stress-grade lumber and its fastenings.

Stresses allowed for joint and plank grades apply to members with the load applied to either the narrow or wide face.

b. Stresses that exceed those given in the tables for the lowest stress-grade of any species shall be used only when the higher grade of that species is identified by the grade mark of, or certificate of inspection by, a lumber grading or inspection bureau or agency recognized as being competent.

STRESSES FOR JOISTS AND PLANKS, BEAMS AND STRINGERS, POSTS AND TIMBERS

1 Species and commercial grade ¹		2 Rules under which graded	Allowable Unit Stresses in Pounds per Square Inch				
			3 Extreme fiber in bending "F" and tension parallel to grain "t"	4 Horizontal shear "H"	5 Compression perpendicular to grain "cT"	6 Modulus of elasticity "E"	7 Compression parallel to grain "c"
Cypress, Southern:							
1700 f Grade	J.&P.-B.&S.	National Hardwood Lumber Association, 1943	1700	145	360	1,200,000	1425
1300 f Grade	J.&P.-B.&S.		1300	120			1125
1450 c Grade	P.&T.		...	...			1450
1200 c Grade	P.&T.		...	...			1200
Cypress, Tidewater Red:							
1700 f Grade	J.&P.-B.&S.	Southern Cypress Manufacturers Assn., 1950	1700	145	360	1,200,000	1425
1300 f Grade	J.&P.-B.&S.		1300	120			1125
1450 c Grade	P.&T.		...	...			1450
1200 c Grade	P.&T.		...	...			1200
Douglas Fir, Coast Region:							
Dense Select Structural ⁵	J.&P. ² -B.&S. ²	West Coast Bureau of Lumber Grades and Inspection, 1948	2150	145	455	1,600,000	1550
Select Structural	J.&P. ² -B.&S. ²		1900	120	415		1450
1700 f. -Dense No. 1 ⁵	J.&P. ² -B.&S. ²		1700	145	455		1325
1450 f. - No. 1	J.&P. ² -B.&S. ²		1450	120	390		1200
1100 f. - No. 2	J.&P.		1100	110	390		1057
Dense Select Structural ⁵	P.&T.		...	...	455		1550
Select Structural	P.&T.		...	...	415		1450
Dense No. 1 ⁵	P.&T.		...	...	455		1400
No. 1	P.&T.		...	...	390		1200
Douglas Fir, Inland Region:							
Select Structural ⁵	J.&P. ²	Western Pine Association, 1953	2150	145	455	1,600,000	1750
Structural	J.&P. ²		1900	100	400	1,500,000	1400
Common Structural	J.&P. ²		1450	95	380	1,500,000	1250
Select Structural ⁵	P.&T.		...	...	455	1,600,000	1750
Structural	P.&T.		...	...	400	1,500,000	1400
Common Structural	P.&T.		...	...	380	1,500,000	1250

1 Species and commercial grade ¹		2 Rules under which graded	Allowable Unit Stresses in Pounds per Square Inch				
			3 Extreme fiber in bending "F" and tension parallel to grain "t"	4 Horizontal shear "H"	5 Compression perpendicular to grain "cT"	6 Modulus of elasticity "E"	7 Compression parallel to grain "c"
Hemlock, Eastern:							
Select Structural	J.&P. ² -B.&S. ²	Northern Hemlock and Hardwood Manufacturers Association, 1950	1300	85	360	1,100,000	850
Prime Structural	J.&P. ²⁻⁸		1200	60			775
Common Structural	J.&P. ²⁻⁸		1100	60			650
Utility Structural	J.&P. ²⁻⁸		950	60			600
Select Structural	P.&T.		...	...			850
Hemlock, West Coast:							
1600 f. – Select Structural	J.&P. ²	West Coast Bureau of Lumber Grades and Inspection, 1948	1600	100	360	1,400,000	1100
1450 f. – No. 1	J.&P. ² -B.&S. ²		1450	100			1075
1100 f. – No. 2	J.&P. ²		1100	90			850
No. 1 Hemlock Timbers	P.&T.		...	...			1075
Maple, Hard:							
2150 f Grade	J.&P.	National Hardwood Lumber Association, 1943	2150	145	600	1,600,000	1750
1900 f Grade	J.&P.-B.&S.		1900	145			1525
1700 f Grade	J.&P.-B.&S.		1700	145			1350
1450 f Grade	J.&P.-B.&S.		1450	120			1150
1550 c Grade	P.&T.		...	...			1550
1450 c Grade	P.&T.		...	...			1450
1200 c Grade	P.&T.		...	...			1200
Oak, Red and White:							
2150 f Grade	J.&P.	National Hardwood Lumber Association, 1943	2150	145	600	1,500,000	1550
1900 f Grade	J.&P.-B.&S.		1900	145			1375
1700 f Grade	J.&P.-B.&S.		1700	145			1200
1450 f Grade	J.&P.-B.&S.		1450	120			1050
1300 f Grade	B.&S.		1300	120			950
1325 c Grade	P.&T.		...	...			1325
1200 c Grade	P.&T.		...	...			1200
1075 c Grade	P.&T.		...	...			1075

1 Species and commercial grade ¹		2 Rules under which graded	Allowable Unit Stresses in Pounds per Square Inch				
			3 Extreme fiber in bending "F" and tension parallel to grain "t"	4 Horizontal shear "H"	5 Compression perpendicular to grain "cT"	6 Modulus of elasticity "E"	7 Compression parallel to grain "c"
Pine, Norway:							
Prime Structural	J.&P. ²⁻⁸	Northern Hemlock and Hardwood Manufacturers Assn., 1947	1200	75	360	1,200,000	900
Common Structural	J.&P. ²⁻⁸		1100	75			775
Utility Structural	J.&P. ²⁻⁸		950	75			650
Pine, Southern: ⁴							
Dense Select Structural ⁵	J.&P.-B.&S.	Southern Pine Inspection Bureau, 1948	2400	120 ⁷	455	1,600,000	1750
Dense Structural ⁵	J.&P.-B.&S.		2000	120 ⁷			1400
Dense Structural S.E.&S. ⁵	J.&P.-B.&S.		1800	120 ⁷			1300
Dense No. 1 Structural ⁵	J.&P.-B.&S.		1600	120 ⁷			1150
No. 1 Dense 1400f ⁹⁻⁵	J.&P.-B.&S.		1400	140			1400
No. 1 1200F ⁵	J.&P.-B.&S.		1200	120			1200
No. 1 Dense ⁵	J.&P. ⁸		1700	150			1400
No. 1	J.&P. ⁸		1450	125			1200
No. 2 Dense ⁵	J.&P. ⁸		1250	100			1025
No. 2	J.&P. ⁸		1100	85			875
Dense Select Structural ⁵	P.&T.		...	...			1750
Dense Structural ⁵	P.&T.		...	...			1400
Dense Structural S.E.&S. ⁵	P.&T.		...	...			1300
Dense No. 1 Structural ⁵	P.&T.		...	...			1150
No. 1 Dense 1400f ⁹⁻⁵	P.&T.		1400	140			1400
No. 1 1200F ⁹	P.&T.		1200	120			1200
Pine, Southern Longleaf: ⁴							
Select Structural Longleaf ⁵⁻⁶	J.&P.-B.&S.	Southern Pine Inspection Bureau, 1948	2400	120 ⁷	455	1,600,000	1750
Prime Structural Longleaf ⁵⁻⁶	J.&P.-B.&S.		200	120 ⁷			1400
Merchantable Structural Longleaf ⁵⁻⁶	J.&P.-B.&S.		1800	120 ⁷			1300
Structural S.E.&S. Longleaf ⁵	J.&P.-B.&S.		1800	120 ⁷			1300
No. 1 Structural Longleaf ⁵	J.&P.-B.&S.		1600	120 ⁷			1150
No. 1 Longleaf 1400f ⁹⁻⁵	J.&P.-B.&S.		1400	140			1400

1 Species and commercial grade ¹		2 Rules under which graded	Allowable Unit Stresses in Pounds per Square Inch				
			3 Extreme fiber in bending "F" and tension parallel to grain "t"	4 Horizontal shear "H"	5 Compression perpendicular to grain "cT"	6 Modulus of elasticity "E"	7 Compression parallel to grain "c"
No. 1 Longleaf ⁵	J.&P. ⁸		1700	150			1400
No. 2 Longleaf ⁵	J.&P. ⁸		1250	100			1025
Select Structural Longleaf ⁵⁻⁶	P.&T.		...	...			1750
Prime Structural Longleaf ⁵⁻⁶	P.&T.		...	...			1400
Merchantable Structural Longleaf ⁵⁻⁶	P.&T.		...	...			1300
Structural S.E.&S. Longleaf ⁵	P.&T.		...	...			1300
No. 1 Structural Longleaf ⁵	J.&P.-B.&S.*		...	...			1150
No. 1 Longleaf 1400f ⁹⁻⁵	P.&T.		1400	140			1400
Poplar, Yellow:							
1500 f Grade	J.&P.	National Hardwood Lumber Assn., 1951	1500	110	300	1,100,000	1200
1250 f Grade	J.&P.-B.&S.		1250	110			950
1075 c Grade	P.&T.		...	...			1075
Redwood:							
Dense Structural ⁵	J.&P. ² -B.&S. ²	California Redwood Association, 1951	1700	110	320	1,200,000	1450
Heart Structural	J.&P. ² -B.&S. ²		1300	95			1100
Dense Structural ⁵	P.&T.		...	...			1450
Heart Structural	P.&T.		...	...			1100
Spruce, Eastern:							
1450 f Structural Grade	J.&P. ²	Northeastern Lumber Manufacturers Association, Inc., 1950	1450	110	300	1,200,000	1050
1300 f Structural Grade	J.&P. ²		1300	95			975
1200 f Structural Grade	J.&P. ²		1200	95			900

*Intended to read "P.&T."

1. Abbreviations: J.&P., Joists and Planks; B.&S., Beams and Stringers; P.&T., Posts and Timbers; S.E.&S., Square Edge and Sound.

2. The allowable stresses for tension and compression parallel to gain given for these Joist and Plank and Beam and Stringer grades are applicable when graded according to Par. 310 of Misc. Pub. 185, U.S. Dept of Agr.

4. According to 1948 Standard Grading Rules, including Supplement No. 1 thereto.

5. These grades meet the requirements for density.

6. These grades are based on requirements for heartwood.

7. The grading rules provide a basis for obtaining higher shearing stresses of 140, 160 and 180 pounds per square inch when specified.

8. These grades are applicable to 2 inch thickness only.

9. These grades are applicable only in sizes 3 inches and thicker.

c. The allowable stresses herein also apply to lumber that has been pressure impregnated by an approved process and preservative.

§C26-370.4 Adjustment of Allowable Stresses.-

a. Allowable unit stresses given in the tables may be used without regard to impact if the stress induced by impact does not exceed the allowable unit stress given therein.

Where a member is to be fully stressed to the maximum allowable stress for many years, either continuously or cumulatively under the condition of maximum design load, the allowable working stresses shall not exceed 90 percent of those in the tables. The provisions of this paragraph apply to modulus of elasticity only when used to determine the allowable loads for columns or other members in compression parallel to grain. They also apply to mechanical fastenings unless otherwise noted.

b. The allowable unit stresses given in the tables and the adjustments thereof apply to stress-grade lumber used under conditions continuously dry, as in most covered structures. When used under other conditions the provisions in the national design specification for stress-grade lumber and its fastenings therefor shall apply.

The allowable unit stress apply to stress-grade lumber that has been pressure impregnated by an approved process and preservative and to the heartwood of a durable species under dry conditions of use. They also apply thereto under other conditions of use except as provided in the national design specification.

c. Horizontal shear. The maximum allowable unit stress in horizontal shear in beams and other members in flexure shall be computed by use of the following formula:

$$H = \frac{3 R}{2b h} \text{ in which}$$

R = reaction, pounds, under the following conditions:

Distribution of load to adjacent beams through flooring or other members shall be considered;

All loads uniform or concentrated, within a distance of the height of the beam from the nearest support shall be neglected;

All concentrated loads located at a distance from the support of one to three times the height of the beam shall be considered as placed at three times the height of the beam from the support.

d. Joint details, compression. In joists supported on a ribbon or ledger board and spiked to the studs, the allowable stress in compression perpendicular to the grain shall be increased fifty percent (50%).

For bearings less than six (6) inches in length and located three (3) inches or more from the end of a timber the allowable compression stresses perpendicular to grain shall be increased in accordance with the following factors:

Length of bearing (inches)	½	1	1½	2	3	4	6 or more
Factor	1.75	1.38	1.25	1.19	1.13	1.10	1.00

For stress under a washer or small plate the same factor may be taken as for a bearing, the length of which equals the diameter of the washer.

e. Shear allowable unit stresses in shear for joint details shall be one hundred fifty percent (150%) of the horizontal shear values otherwise permitted.

In computing the horizontal shear in eccentric joints the effective depth of the member shall be assumed as its actual depth less the distance from the unloaded edge to the nearest edge of the nearest connector. Where bolts alone are used subtract the distance from the unloaded edge to the center of the nearest bolt.

f. Notches. Where girders, beams or joists are notched they shall meet design requirements for net section in bending and in shear. Beams notched upward in the face at their bearing on supports shall be limited to the maximum end reaction “V” as determined by the formula:

$$V = \frac{2bd^2H}{3h} \text{ in which}$$

“V” is the vertical shear at the section under consideration, “b” is the breadth and “h” is the total depth of the member, “d” is the height of the member above the notch, and “H” is the allowable stress in horizontal shear.

§C26-370.5 Timber Column Design.-

a. Simple solid wood columns consist of a single piece.

The safe load, in pounds per square inch, of net cross-sectional area for single solid columns, and other solid members stressed in compression parallel to the grain shall be determined by the following formula:

$$P/A = \frac{0.30 E}{(l/d)^2}$$

--but the maximum unit load (P / A) shall not exceed the allowable unit stress in compression parallel to grain "c" as set forth in the tables adjusted as otherwise provided.

Simple- solid columns shall be limited in maximum length to $l/d = 50$.

A = area in square inches of net cross-section.

d = least dimension, of columns, in inches.

E = modulus of elasticity, "E", in tables adjusted as provided.

l = laterally unsupported length of column, in inches.

P = total load, in pounds.

P / A = maximum axial load, in pounds per square inch.

b. Spaced Member Columns. Columns formed of two or more individual members separated by blocking at the ends and middle points of their length and joined at the ends by approved timber connectors shall be designed in accordance with the national design specification for stress-grade lumber and its fastenings.

The individual members of spaced columns shall be limited in maximum length to $l/d = 80$.

c. Round Columns. The allowable load for a column of round cross-section shall not exceed that permitted for a square column of the same cross-sectional area.

d. Built-up columns. Built-up columns composed of two or more members spiked or bolted together shall be designed in accordance with the principles set forth in the National Design Specifications for Stress-Grade Lumber and Its Fastenings.

§C26-370.6 Timber Connectors and Fastenings.-Except as otherwise provided, the design with, allowable loads for, and installation of timber connectors and other mechanical fastenings of wood members shall be in accordance with the National Design Specification for Stress-Grade Lumber and its Fastenings.

(7.4.7.1). §C26-371.0 Grade-Marked Timbers.-Grade-marked timbers of higher structural qualities and grades may be approved by the superintendent for use with higher stresses based on authoritative test data.

GROUP 8

Allowable Working Stresses for Wind Loads

(7.4.8.1). §C26-372.0 Maximum Negligible Wind Stress.-When the stress in any member due to wind is less than thirty-three and one-third percent of the stress due to live and dead loads, such stress due to wind may be neglected.

(7.4.8.2). §C26-373.0 Combined Stresses.-For combined stresses due to wind and other loads the permissible working stress may be increased by thirty-three and one-third percent, provided the section thus found is at least that required by the dead and live loads alone.

(7.4.8.3). §C26-374.0 Stresses From Wind Only.-For stresses due to wind only, the permissible working stress shall be the same as for live and dead loads, with the exception of rivets, bolts and welds, where the permissible working stress may be increased by thirty-three and one-third percent.

(7.4.8.4). §C26-375.0 Wind Loads When Special Steels Are Used.-If the use of any special steel shall be contemplated, with higher unit stresses for live and dead loads corresponding with the greater strength of such steel, it shall be permissible to increase materially the stresses imposed by assumed wind pressure alone, over those specified for low carbon steels only after a careful consideration of the effect of such increase on the general rigidity of the structure contemplated.

GROUP 9

Allowable Working Stresses for Structural Aluminum

§C26-375.1 Allowable Working Stresses for Different Aluminum Alloys.-

a. It shall be unlawful to use aluminum alloy structural members except as provided in section C26-325.2.

b. Allowable working stresses for structural aluminum of alloys 6061-T6 and 6062-T6.

1. The allowable stresses to be used in proportioning the parts of a structure where the alloys known commercially as 6061-T6 and 6062-T6 are used shall be determined from tables 1 through 4. The terms appearing in the formulas shown in the tables are defined as follows:

- a_1 = shorter span of rectangular shear panel, in.
- a_2 = longer span of rectangular shear panel, in.
- a_e = equivalent span of rectangular shear panel, in.
- b = clear width of outstanding flange or of flat plate supported on both unloaded edges, in.
- d = depth of beam, in.
- d_1 = distance from toe of compression flange to neutral axis, in.
- h = clear height of shear web, in.
- I_y = moment of inertia of a beam (about axis parallel to web), in.⁴
- L = length of compression member between points of lateral support or twice the length of a cantilever column (except where analysis shows that a shorter length can be used), in.
- L_b = length of beam between points at which the compression flange is supported against lateral movement or length of cantilever beam from free end to point at which the compression flange is supported against lateral movement, in.
- R = outside radius of a round tube or maximum outside radius for all oval tube, in.
- R_b = outside radius of a round tube in bending or outside radius at the location of the critical compressive stress for an oval tube in bending. in. (The location of the critical compressive stress is at the extreme fiber for an oval tube bent about the major axis. For an oval tube bent about the minor axis, the location of the critical

stress can be determined by calculating the allowable stress at several points with R_b equal to the outside radius at each point. Bending moments corresponding to the allowable stresses at the various points are calculated, and the point resulting in the smallest bending moment is the location of the critical compressive stress.)

- $r =$ least radius of gyration of a column, in.
 $r_y =$ radius of gyration of a beam about axis parallel to web, in. (For beams that are unsymmetrical about the horizontal axis, r_y should be calculated as though both flanges were the same as the compression flange.)
 $S_e =$ section modulus of a beam (compression side). in.³
 $t =$ thickness of flange, plate, web or tube, in. (For tapered flanges, t is the average thickness.)

2. Limiting slenderness ratio for columns.

The slenderness ratio L / r for columns shall not exceed 120.

3. Combined compression and bending.

The allowable stress in a member subjected to both compression and bending shall be determined from one of the following three formulas:

If the bending moment at the center of the span is equal to or greater than 0.9 of the maximum bending moment in the span,

$$\frac{f_a}{F_a} + \frac{f_b}{F_b(1 - f_a/F_e)} \leq 1$$

(1)

where $f_a =$ average compressive stress on cross section of member produced by compressive load, ksi.

$f_b =$ maximum bending stress (compression) caused by transverse loads or end moments in the absence of axial load, ksi.

$F_a =$ allowable compressive stress for member considered as an axially loaded column, ksi.

$F_b =$ allowable compressive stress for member considered as a beam, ksi.

$F_e = 51,000 / (L / r)^2$ in which $L / r =$ slenderness ratio for member considered as a column tending to fail in the plane of the applied bending forces.

If the bending moment at the center of the span is not more than one-half the maximum bending moment in the span,

(2)

$$\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1$$

If the moment at the center of the span is between 0.5 and 0.9 of the maximum moment,

(3)

$$\frac{f_a}{F_a} + \frac{f_b}{F_b[1 - (2M_c/M_m - 1) f_a/F_e]} \leq 1$$

Where $M_c =$ bending moment at center of span resulting from applied bending loads, in-kips.

$M_m =$ maximum bending moment in span resulting from applied bending loads, in-kips.

4. Cross sections with part of all area affected by heat of welding.

If less than 15 percent of the area of a given cross section lies within one inch of a weld, the effect of the welds can be neglected and allowable stress for that cross section can be calculated by the formulas in table 1. If the area of a cross section that lies within one inch of a weld is

between 15 percent and 100 percent of the total area of the cross section, the allowable stress shall be calculated by the following formula:

(4)

$$f_{pw} = f_n - \frac{A_w}{A} (f_n - f_w)$$

Where f_{pw} = allowable stress on cross section, part of whose area lies within one inch of a weld, ksi.

f_n = allowable stress for same cross section if there were no welds present (see table 1), ksi.

f_w = allowable stress for same cross section if entire area lies within one inch of a weld (see table 2), ksi.

A = net area of cross section of a tension member or tension flange of a beam, or gross area of cross section of a compression member or compression flange of a beam, sq. in. (A beam flange is considered to consist of that portion of the member farther than $2c/3$ from the neutral axis, where c is the distance from the neutral axis to the extreme fiber).

A_w = area within area A that lies within one inch of weld, sq. in.

5. Columns and single web beams with welds at locations other than ends and cantilever columns and single web beams.

The allowable stresses in specifications I-7b and I-8b (see table 2) apply to members supported at both ends with welds at the end only (not farther from the supports than 0.05 of the length of the column or beam).

For cantilever columns or beams and for columns and beams having welds at locations other than the ends, the allowable stress shall be determined from the following:

Members with welds affecting the entire cross section:

(5)

$$f_n > 18.4,$$

$$18.4 \geq f_n > 3.8,$$

$$f_n \leq 3.8,$$

$$f_w = 11$$

$$f_w = \frac{15.5}{\sqrt{20.4 - f_n}}$$

$$f_w = f_n$$

where f_n and f_w are as previously defined.

Members with welds affecting less than the entire cross section:

The allowable stress shall be determined from Eq. 4, where the value of f_w is given by Eq. 5.

6. Single web beams and girders.

The simplified formulas of table 1 give very conservative values of allowable stress of values of L_b / r_y exceeding about 50. If the designer wishes to compute more precise values of allowable compressive stress for single web beams and girders, the value of r_y , in specification A-11b may be replaced by an “effective r_y ” given by the following formula:

(6)

$$\text{Effective } r_y = \frac{1}{1.7} \sqrt{\frac{I_y d}{S_e} \sqrt{1 + 0.152 \frac{J}{I_y} \left(\frac{L_b}{d}\right)^2}}$$

where d = depth of beam, in.

I_y = moment of inertia of beam about axis parallel to web, in.⁴

J = torsion constant of beam, in.⁴

S_e = section modulus of beam for compression flange, in.³

7. In applications where it is conventional practice to increase allowable stresses for certain types of loads, such as wind loads, the allowable stresses in these specifications should be increased in the same proportion as are the allowable stresses in accepted specifications for steel structures. (See Tables 1 and 2.)

Table 3
ALLOWABLE SHEAR STRESSES IN RIVETS AND BOLTS
(BUILDING STRUCTURES)

Specification Number	Description of Rivets or Bolts	Allowable Stress, ksi	
		Shear on Effective Shear Area	Tension on Root Area
A-22b	6061-T6 rivets, cold driven	11	..
A-23b	6061-T43 rivets, driven at temperatures of from 900°F to 1,050°F	9	..
A-24b	2024-T4 bolts	16 _a	26
A-25b	6061-T6 pins	11	..

a. This allowable shear stress applies to either turned bolts in reamed holes or unfinished bolts in 1/16-in. oversize holes.

Table 4
ALLOWABLE SHEAR STRESSES IN FILLET WELDS
(BUILDING STRUCTURES)

Specification Number	Filler Alloy	Allowable Shear Stress, _a ksi	
		Transverse Shear in Single Fillet Welds or Longitudinal Shear, _b	Transverse Shear in Double Fillet Welds, _b
I-22b	5556	8.5	9 _c
I-23b	5356	7	9 _c
I-24b	4043	5	7

a. Shear stress is considered to be equal to the load divided by the throat area, regardless of the direction of loading.

b. Single fillet welds in transverse shear may be treated as double fillet welds in joints so designed as to prevent local bending of the parts adjacent to the fillet weld.

c These values are controlled by the shear strength of the parent material; all other values are controlled by the strength of the filler metal.

c. All parts of the structures shall be so proportioned that the sum of the maximum static stresses for the aluminum alloy known commercially as 2014-T6 shall be within the following:

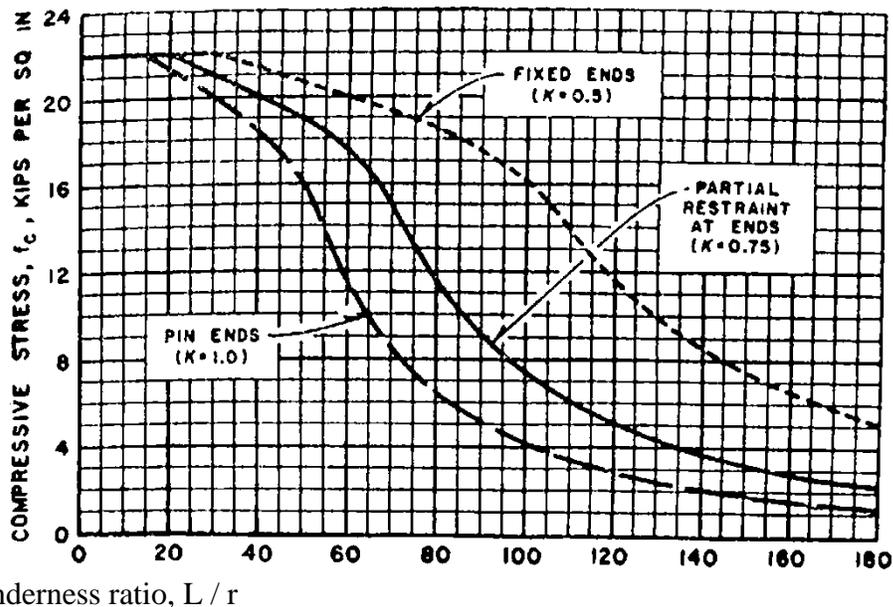
1. Tension stresses.

	Kips per square inch
(1) Axial tension	22
(2) Tension in extreme fibers of shapes subject to bending, net section	22

2. Axial compression.

(1) Allowable compression stress on the gross section of axially loaded columns shall be determined from curves in Graph, in Figure 1a and Figure 4a, whichever is smaller.

Figure 1a. Allowable compressive stresses for axially loaded columns (gross section)



Slenderness ratio, L / r

The value of K in graph, in figure 1a, describes the end restraint of the column. Values smaller than 0.75 shall not be used unless a detailed analysis of the structure justifies complete fixed assumption for the column ends. The slenderness ratio L / r for columns shall not exceed 120.

The formulas for the three curves in graph, in figure 1a, can be written as follows:

$$f_c = \frac{\pi^2 E_t}{2.5 \left(\frac{kL}{r}\right)^2} \text{ in which}$$

f_c is the allowable compressive stress on the gross cross-sectional area in kips per square inch.

E_t is the tangent modulus taken from figure 2a, using a stress of 2.5 times f_c in kips per square inch.

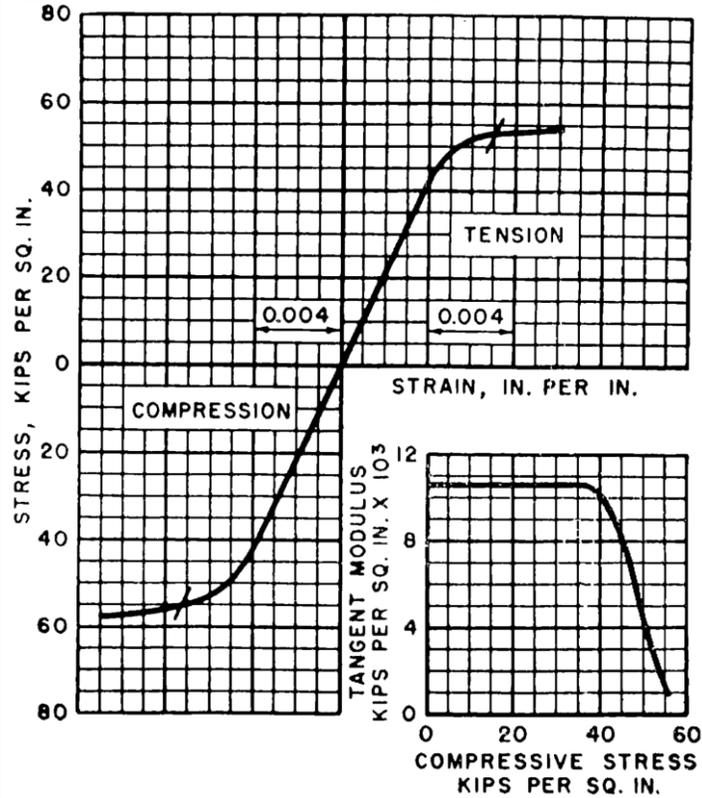
r is the least radius of gyration of the column in inches.

K is the factor for end restraint.

For values of L / r greater than 72, and K equal to 75, the formula $f_c =$

$$\frac{74,000}{\left(\frac{L}{r}\right)^2} \text{ can be used}$$

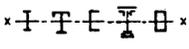
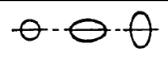
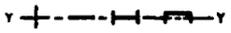
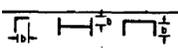
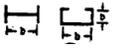
Figure 2a.-Stress strain and tangent modulus curves.

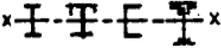
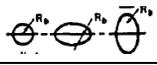
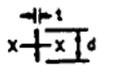
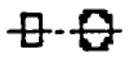
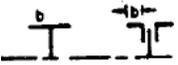
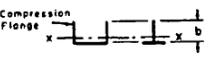


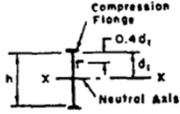
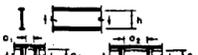
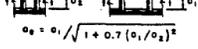
3. Compression in the extreme fibers of shapes subject to bending. Note: (Built-up sections are not included)

The allowable compressive stress in the extreme fiber of single-web rolled shapes, or extruded shapes shall be determined from graphs in figure 3a, or figure 4a, whichever is smaller.

Table 1
ALLOWABLE STRESSES IN RIVETED OR BOLTED STRUCTURES AT LOCATIONS FARTHER THAN 1.0 INCH FROM ANY WELD (6061-T6 AND 6062-T6 BUILDING STRUCTURES NONWELDED)

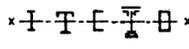
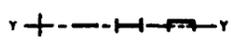
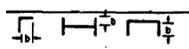
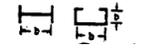
Type of Stress		Speci- fica- tion No.	Type of Member or Component		Allowable Stress, ksi				
TENSION, axial, net section		A-1b	Any tension member		19				
TENSION in extreme fibers of beams, net section		A-2b	Structural shapes, rectangular tubes, built-up members bent about X-axis		19				
		A-3b	Round or oval tubes		24				
		A-4b	Rectangular bars and plates, and outstanding flanges of shapes bent about Y-axis		26				
BEARING		A-5b	On rivets and bolts		34 ^(a)				
		A-6b	On milled surfaces and pins		23				
					Allowable Stress for Slenderness Less Than S ₁ , ksi	Slenderness Limit, S ₁	Allowable Stress for Slenderness Between S ₁ and S ₂ , ksi	Slenderness Limit, S ₂	Allowable Stress for Slenderness Greater Than S ₂ , ksi
COMPRESSION in Columns Subjected to Axial Load, Gross Section	COMPRESSION gross section (Also see Specs A-8b to A-10b)	A-7b	Columns		19	$\frac{L}{r} = 10$	$20.4 - 0.135 \frac{L}{r}$	$\frac{L}{r} = 67$	$\frac{51,000}{(L/r)^2}$
	COMPRESSION in components of columns (Also see Spec. A-7b)	A-8b	Outstanding flanges and legs		19	$\frac{b}{t} = 5.5$	$23.7 - 0.86 \frac{b}{t}$	$\frac{b}{t} = 12$	$\frac{1,940}{(b/t)^2}$
		A-9b	Flat plates with both edges supported		19	$\frac{b}{t} = 17$	$23.7 - 0.27 \frac{b}{t}$	$\frac{b}{t} = 38$	$\frac{19,200}{(b/t)^2}$
		A-10b	Curved plates supported on		19	$\frac{R}{t} = 22$	$22.6 - 0.76 \sqrt{\frac{R}{t}}$	$\frac{R}{t} = 125$	...

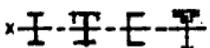
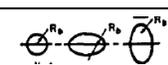
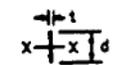
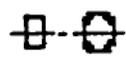
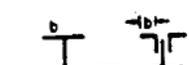
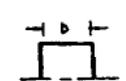
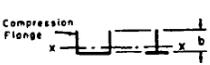
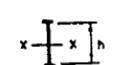
Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi					
			both edges and walls of round or oval tubes						
COMPRESSION in Members Subjected to Bending, Gross Section	COMPRESSION ^(a) in extreme fibers of beams, gross section (Also see Specs. I-15b to I-19b)	I-11b	Single-web structural shapes and built-up sections bent about X-axis ^(a)		11 ^(b)	...	11 ^(b)	$\frac{L_b}{r_y} = 82^{(c)}$	$\frac{74,000}{(L_b/r_y)^2}$
		I-12b	Round or oval tubes		13 ^(b)	$\frac{R_b}{t} = 13^{(c)}$	$\frac{24.7}{(R_b/t)^{1/4}}$	$\frac{R_b}{t} = 135$	...
		I-13b	Solid rectangular beams bent about X-axis		13 ^(b)	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 11^{(c)}$	$\frac{42.3}{[(d/t)^2 L_b/d]^{1/4}}$	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 38$	$\frac{9,900}{\left(\frac{d}{t}\right)^2 \frac{L_b}{d}}$
		I-14b	Rectangular tubes and box sections ^(a)		11 ^(b)	...	11 ^(b)	$\frac{L_b S_c}{I_y} = 1820^{(c)}$	$\frac{20,000}{L_b S_c / I_y}$
	COMPRESSION in components of beams, where component is under uniform compression (Also see Specs. I-11b to I-14b)	I-15b	Flat plates with one edge free and one edge supported		11 ^(b)	$\frac{b}{t} = 5.3^{(c)}$	$\frac{25.4}{\sqrt{b/t}}$	$\frac{b}{t} = 21$	$\frac{2,500}{(b/t)^2}$
		I-16b	Flat plates with both edges supported		11 ^(b)	...	11 ^(b)	$\frac{b}{t} = 44^{(c)}$	$\frac{19,200}{(b/t)^2}$
	COMPRESSION in components of beams where component is under bending in its own plane, (Also see Specs. I-11b to I-14b)	I-17b	Flat plates with compression edge free and tension edge supported, bent about X-axis		13 ^(b)	$\frac{b}{t} = 6.8^{(c)}$	$\frac{34.0}{\sqrt{b/t}}$	$\frac{b}{t} = 25$	$\frac{4,200}{(b/t)^2}$
		I-18b	Flat plates with both edges supported, bent about X-		11 ^(b)	...	11 ^(b)	$\frac{h}{t} = 144^{(c)}$	$\frac{230,000}{(h/t)^2}$

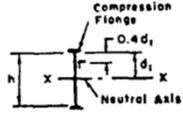
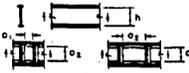
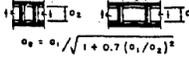
Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi				
			axis					
		I-19b	Flat plates with both edges supported, bent about X-axis with horizontal stiffener 	11 ^(b)	...	11 ^(b)	$\frac{h}{t} = 300^{(c)}$	$\frac{990,000}{(h/t)^2}$
SHEAR in webs of beams, and also in members subjected to torsion, gross section	I-20b	Unstiffened flat webs		7 ^(b)	...	7 ^(b)	$\frac{h}{t} = 69^{(c)}$	$\frac{33,000}{(h/t)^2}$
	I-21b	Stiffened flat webs	 $a_e = a_s / \sqrt{1 + 0.7 (a_s / a_e)^2}$	7 ^(b)	...	7 ^(b)	$\frac{a_e}{t} = 87^{(c)}$	$\frac{53,000}{(a_e/t)^2}$

- (a) The allowable stresses for columns, single web beams and rectangular tubes and box sections apply to members supported at both ends and welded at the ends only. See Specification I-26 for allowable stresses in these members with welds at locations other than the ends and in cantilever columns and beams.
- (b) These allowable stresses apply to all material welded with 5556 or 5356 filler alloy and to material 3/8-in. or less in thickness welded with 4043 filler alloy. For thicker material welded with 4043 filler alloy, these allowable stresses shall be reduced by multiply them by 0.8. Allowable stresses not marked with a superscript apply to material welded with either 4043, 5556 or 5356 filler alloy.
- (c) These slenderness limits apply to all material welded with 5556 or 5356 filler alloy and to material 3/8-in. or less in thickness welded with 4043 filler alloy/ For thicker material welded with 4043 filler alloy, these slenderness limits must be adjusted to correspond to the reduced values of maximum allowable stresses indicated in Note (b) above.
- (d) This value applies for a ratio of edge distance to rivet or bolt diameter of 2 or more. For smaller ratios, multiply this allowable stress by the ratio, (edge distance)/(twice the rivet or bolt diameter).

Table 2
ALLOWABLE STRESSES ON SECTIONS WITHIN 1.0 INCH OF A WELD (6061-T6 AND 6062-T6 BUILDING STRUCTURES WELDED)

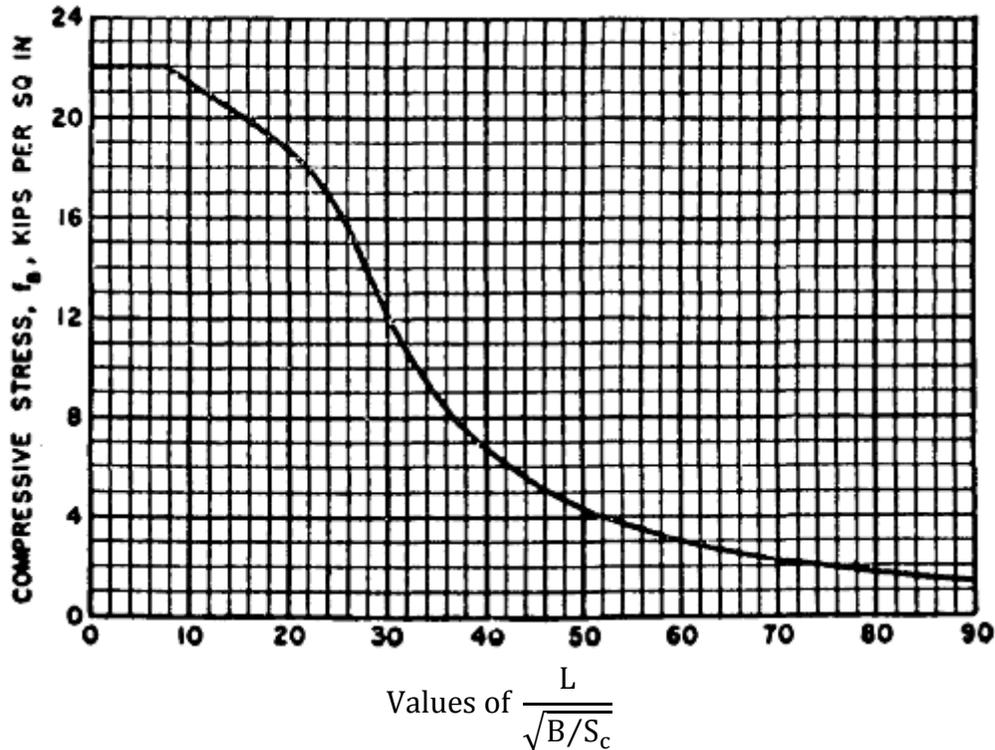
Type of Stress		Speci- fica- tion No.	Type of Member or Component		Allowable Stress, ksi				
TENSION, axial, net section		I-1b	Any tension member		11 ^(b)				
TENSION in extreme fibers of beams, net section		I-2b	Structural shapes, rectangular tubes, built-up members bent about X-axis		11 ^(b)				
		I-3b	Round or oval tubes		13 ^(b)				
		I-4b	Rectangular bars and plates, and outstanding flanges of shapes bent about Y-axis		13 ^(b)				
BEARING		I-5b	On rivets and bolts		18 ^{(b)(d)}				
		I-6b	On milled surfaces and pins		12 ^(b)				
					Allowable Stress for Slenderness Less Than S ₁ , ksi	Slenderness Limit, S ₁	Allowable Stress for Slenderness Between S ₁ and S ₂ , ksi	Slenderness Limit, S ₂	Allowable Stress for Slenderness Greater Than S ₂ , ksi
COMPRESSION in Columns Subjected to Axial Load, Gross Section	COMPRESSION ^(a) gross section (Also see Specs. I-8b to I-10b)	I-7b	Columns ^(a)		11 ^(b)	...	11 ^(b)	$\frac{L}{r} = 68^{(c)}$	$\frac{51,000}{(L/r)^2}$
	COMPRESSION in components of columns (Also see Spec. I-7b)	I-8b	Outstanding flanges and legs		11 ^(b)	$\frac{b}{t} = 4.9^{(c)}$	$\frac{24.4}{\sqrt{b/t}}$	$\frac{b}{t} = 19$	$\frac{1,940}{(b/t)^2}$
		I-9b	Flat plates with both edges supported		11 ^(b)	...	11 ^(b)	$\frac{b}{t} = 44^{(c)}$	$\frac{19,200}{(b/t)^2}$
		I-10b	Curved plates supported on		11 ^(b)	$\frac{R}{t} = 14^{(c)}$	$\frac{21.3}{(R/t)^{1/4}}$	$\frac{R}{t} = 200$...

Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi					
			both edges and walls of round or oval tubes						
COMPRESSION in Members Subjected to Bending, Gross Section	COMPRESSION in extreme fibers of beams, gross section (Also see Specs. A-15b to A-19b)	A-11b	Single-web structural shapes and built-up sections bent about X-axis 	19	$\frac{L_b}{r_y} = 12$	$20.4 - 0.113 \frac{L_b}{r_y}$	$\frac{L_b}{r_y} = 81$	$\frac{74,000}{(L_b/r_y)^2}$	
		A-12b	Round or oval tubes 	24	$\frac{R_b}{t} = 19$	$28.2 - 0.22 \frac{R_b}{t}$	$\frac{R_b}{t} = 60$...	
		A-13b	Solid rectangular beams bent about X-axis 	26	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 11$	$34.9 - 0.80 \frac{d}{t} \sqrt{\frac{L_b}{d}}$	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 29$	$\frac{9,900}{(\frac{d}{t})^2 \frac{L_b}{d}}$	
		A-14b	Rectangular tubes and box sections 	19	$\frac{L_b S_c}{I_y} = 40$	$20.4 - 0.22 \sqrt{\frac{L_b S_c}{I_y}}$	$\frac{L_b S_c}{I_y} = 1810$	$\frac{20,000}{L_b S_c / I_y}$	
	COMPRESSION in components of beams, where component is under uniform compression (Also see Specs A11b to A-14b)	A-15b	Flat plates with one edge free and one edge supported 	19	$\frac{b}{t} = 6.2$	$23.7 - 0.76 \frac{b}{t}$	$\frac{b}{t} = 14$	$\frac{2,500}{(b/t)^2}$	
		A-16b	Flat plates with both edges supported 	19	$\frac{b}{t} = 17$	$23.7 - 0.27 \frac{b}{t}$	$\frac{b}{t} = 38$	$\frac{19,200}{(b/t)^2}$	
	COMPRESSION in components of beams where component is under bending in its own plane (Also see Specs. A-11b to A-14b)	A-17b	Flat plates with compression edge free and tension edge supported, bent about X- axis 	26	$\frac{b}{t} = 7.3$	$34.9 - 1.24 \frac{b}{t}$	$\frac{b}{t} = 19$	$\frac{4,200}{(b/t)^2}$	
		A-18b	Flat plates with both edges supported, bent about X- axis 	19	...	19	$\frac{h}{t} = 110$	$\frac{230,000}{(h/t)^2}$	

Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi				
		A-19b	Flat plates with both edges supported, bent about X-axis with horizontal stiffener 	19	...	19	$\frac{h}{t} = 228$	$\frac{990,000}{(h/t)^2}$
SHEAR in webs of beams, and also in members subjected to torsion, gross section	A-20b	Unstiffened flat webs		12	$\frac{h}{t} = 18$	$13.7 - 0.092 \frac{h}{t}$	$\frac{h}{t} = 66$	$\frac{33,000}{(h/t)^2}$
	A-21b	Stiffened flat webs	 $a_e = a_1 / \sqrt{1 + 0.7(a_1/a_2)^2}$	12	...	12	$\frac{a_e}{t} = 66$	$\frac{53,000}{(a_e/t)^2}$

(a) This value applies for a ratio of edge distance to rivet or bolt diameter of 2 or greater. For smaller ratios, multiply this allowable stress by the ratio, (edge distance)/(twice the rivet or bolt diameter).

Figure 3a.-Allowable compressive stresses in beam and girder flanges (gross section)



The terms used in figure 3a, are defined as follows:

L is the laterally unsupported length of beam (clear distance between supports at which beam is prevented from lateral displacement.)

In the case of a cantilever beam with one end free, L is four-thirds (4/3) of the laterally unsupported length in inches.

S_c is the section modulus for the beam about the axis normal to the web compression side in inches cubed.

B is defined by the formula $B = I_1 d \sqrt{11.7 + \frac{J}{I_1} \left(\frac{L}{d}\right)^2}$

I_1 is the moment of inertia about axis parallel to the web in inches fourth.

J is the torsion factor in inches to the fourth power.

d is the depth of beam in inches.

For values of $\frac{L}{\sqrt{B/S_c}}$ greater than 27.5, the curve in Figure 3a, may be represented by the formula $f_B = \frac{10,900}{\left(\frac{L}{\sqrt{B/S_c}}\right)^3}$

The permitted maximum compression stress shall not exceed the allowable values for local buckling.

4. Compression in plates, legs, and webs when limited by local buckling.

(1) The allowable compressive stress in outstanding legs shall be determined from curves in graph in figure 4a, and the requirements of subdivision 2 of this section, whichever is smaller.

Figure 4a.-Allowable compressive stresses in outstanding legs of single-angle and T-section struts (gross section)

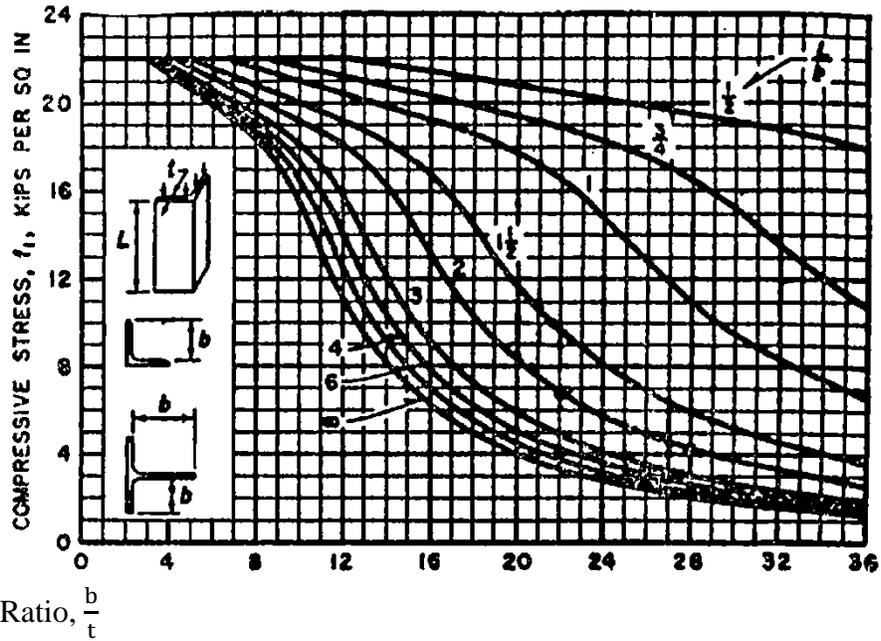
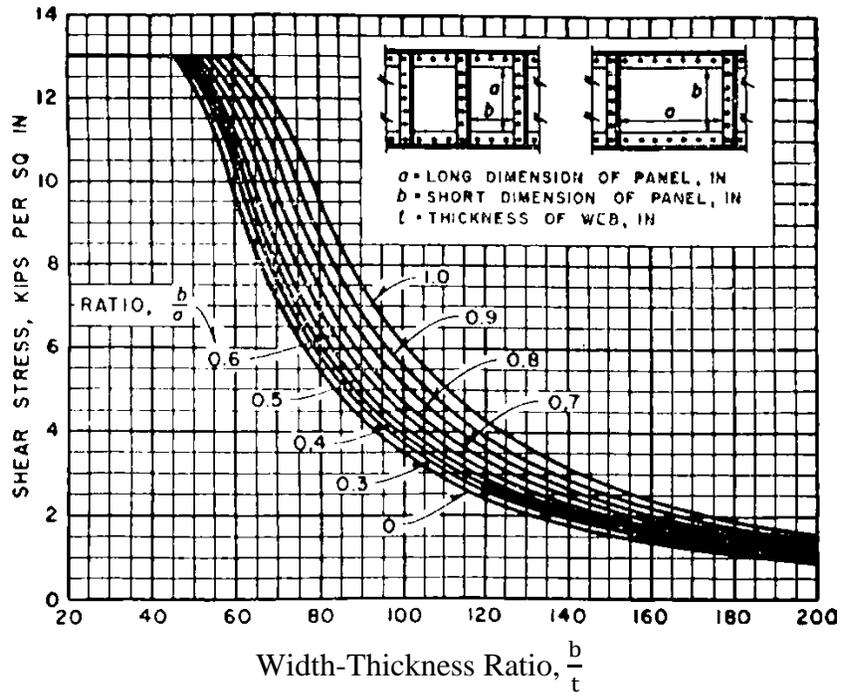


Figure 5a.-Allowable shear stresses on webs; partial restraint assumed at edges of rectangular panels (gross section)



	Stress in kips per square inch
5. Stresses in extreme fibers of pins	34
6. Shear in aluminum alloy 2117-T3 rivets cold-driven	10
7. Shear in aluminum alloy 6061-T43 rivets driven at temperatures from 990°F to 1,050°F	8
8. Shear in turned bolts of aluminum alloy 2014-T4 in reamed holes	12
9. Shear in pins	16
10. Allowable shear in plates and webs on net area shall be determined from curves in graph in Figure 5a	
11. Bearing on pins	30
12. Bearing on hot-driven or cold-driven rivets, milled stiffeners, turned bolts in reamed holes	36

This value shall be reduced for thin plates and shapes as provided in Table 1a.

Table 1a.-Percentage Reduction in Shear Strength of Aluminum Alloy Rivets Resulting From Their Use in Thin Plates and Shapes.									
Ratio, ^a $\frac{D}{t}$	Loss in double shear ^b	Ratio, ^a $\frac{D}{t}$	Loss in double shear ^b	Ratio, ^a $\frac{D}{t}$	Loss in:		Ratio, ^a $\frac{D}{t}$	Loss in:	
(1)	(3)	(1)	(3)	(1)	Single shear (2)	Double shear (3)	(1)	Single shear (2)	Double shear (3)
1.5	0	2.2	9.1	2.9	0	18.2	3.5	2.0	26.0
1.6	1.3	2.3	10.4	3.0	0	19.5	3.6	2.4	27.3
1.7	2.6	2.4	11.7	3.1	0.4	20.8	3.7	2.8	28.0
1.8	3.9	2.5	13.0	3.2	0.8	22.1	3.8	3.2	29.9
1.9	5.2	2.6	14.3	3.3	1.2	23.4	3.9	3.6	31.2
2.0	6.5	2.7	15.6	3.4	1.6	24.7	4.0	4.0	32.5
2.1	7.8	2.8	16.9	...	...	...	...	...	...

a. Ratio of the rivet diameter, D, to the plate thickness, t. The thickness used is that of the thinnest plate in a single shear joint or of the middle plate in a double shear joint.

b. The percentage loss of strength in single shear is zero for D/t less than 3.0.

13. Combined compression and bending.

(1) The allowable stress in a member having both compression and bending shall be determined as follows:

$$f_b = f_B \left(1 - \frac{P/A}{f_c} \right) \left(1 - \frac{P/A}{f_{CE}} \right)$$

All stresses are in kips per square inch.

f_b is the maximum bending compressive stress at center of unsupported length, in addition to the compressive stress P/A .

P/A is the average compressive stress on the gross cross-section, A, of the member, produced by a column load, P.

f_B is the allowable compressive working stress for the member considered as a beam.

f_c is the allowable working stress for the member considered as an axially loaded column, and

$$f_{CE} = \frac{74,000}{\left(\frac{L}{r}\right)^2} \text{ in which } \frac{L}{r} \text{ is the slenderness ratio for the member considered as a column}$$

tending to fail in the plane of the bending force.

§C26-375.2 Allowable working stresses for structural aluminum of alloy 6063-T6 and 6063-T5.-

a. The allowable stresses to be used in proportioning the parts of a structure where the aluminum alloy known commercially as 6063-T6 and 6063-T5 is used shall be determined from tables 3C to 6C and 3D to 6D. Specifications A1-c to A-22c and I-1c to I-21c in tables 3C to 6C shall apply to alloy 6063-T6. The terms appearing in the formulas shown in the tables are defined as follows:

- b = clear width of outstanding flange or of flat plate supported on both unloaded edges, in.
- d = depth of beam, in.
- d_1 = distance from toe of compression flange to neutral axis, in.
- h = clear height of shear web, in.
- I_y = moment of inertia of a beam (about axis parallel to web), in.⁴
- L = length of compression member between points of lateral support or twice the length of a cantilever column (except where analysis shows that a shorter length can be used), in.
- L_b = length of beam between points at which the compression flange is supported against lateral movement or length of cantilever beam from free end to point at which the compression flange is supported against lateral movement, in.
- R = outside radius of round tube or maximum outside radius for an oval tube, in.
- R_b = outside radius of a round tube in bending or outside radius at the location of the critical compressive stress for an oval tube in bending, in. (The location of the critical compressive stress is at the extreme fiber for an oval tube bent about the major axis. For an oval tube bent about the minor axis, the location of the critical stress can be determined by calculating the allowable stress at several points with R_b equal to the outside radius at each point. Bending moments corresponding to the allowable stresses at the various points are calculated, and the point resulting in the smallest bending moment is the location of the critical stress.)
- r = least radius of gyration of a column, in.
- r_y = radius of gyration of a beam (about axis parallel to web), in. (For beams that are unsymmetrical about the horizontal axis, r_y should be calculated as though both flanges were the same as the compression flange.)
- S_c = section modulus of a beam (compression side), in.³
- t = thickness of flange, plate, web or tube, in. (For tapered flanges, is the average thickness.)

b. Limiting slenderness ratio for columns.

The slenderness ratio L / r for columns shall not exceed 120.

c. Combined compression and bending.

The allowable stress in a member subjected to both compression and bending shall be determined from one of the following three formulas:

If the bending moment at the center of the span is equal to or greater than 0.9 of the maximum bending moment in the span,

$$\frac{f_a}{F_a} = \frac{f_b}{F_b(1 - f_a/F_e)} \leq 1$$

(1)

where f_a = average compressive stress on cross section of member produced by axial compressive load, ksi.

f_b = maximum bending stress (compression) caused by transverse loads or end moments in the absence of axial load, ksi.

F_a = allowable compressive stress for member considered as an axially loaded column, ksi.

F_b = allowable compressive stress for member considered as a beam, ksi

$F_c = 51,000/(L/r)^2$

in which L/r = slenderness ratio for member considered as a column tending to fail in the plane of the applied bending forces.

If the bending moment at the center of the span is not more than one-half the maximum bending moment in the span,

$$\frac{f_a}{F_a} = \frac{f_b}{F_b} \leq 1$$

(2)

If the moment at the center of the span is between 0.5 and 0.9 of the maximum moment,

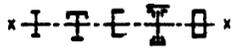
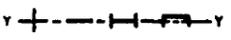
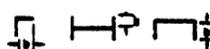
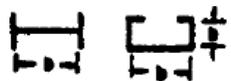
$$\frac{f_a}{F_a} + \frac{f_b}{F_b[1 - (2 M_c/M_m - 1) f_a/F_e]} \leq 1$$

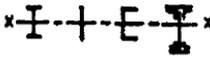
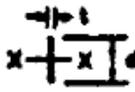
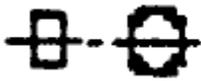
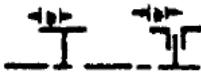
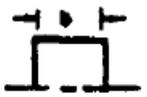
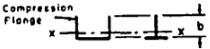
(3)

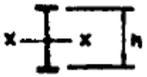
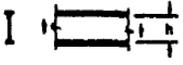
where M_c = bending moment at center of span resulting from applied bending loads, in-kips

M_m = maximum bending moment in span resulting from applied bending loads, in-kips

TABLE 3C
ALLOWABLE STRESSES IN RIVETED OR BOLTED STRUCTURES OR IN WELDED STRUCTURES AT LOCATIONS FARTHER
THAN 1.0 INCH FROM ANY WELD (BUILDING STRUCTURES)
6063-T6 BUILDING STRUCTURES NONWELDED

Type of Stress		Speci- fica- tion No.	Type of Member or Component		Allowable Stress, ksi				
TENSION, axial, net section		A-1c	Any tension member		15				
TENSION in extreme fibers of beams, net section		A-2c	Structural shapes, rectangular tubes, built- up members bent about X-axis		15				
		A-3c	Round or oval tubes		17				
		A-4c	Rectangular bars and plates, and outstanding flanges of shapes bent about Y-axis		19				
BEARING		A-5c	On rivets and bolts		24 ^(a)				
		A-6c	On milled surfaces and pins		16				
					Allowable Stress for Slenderness Less Than S₁, ksi	Slenderness Limit, S₁	Allowable Stress for Slenderness Between S₁ and S₂, ksi	Slenderness Limit, S₂	Allowable Stress for Slenderness Greater Than S₂, ksi
COMPRESSION in Columns Subjected to Axial Load, Gross Section	COMPRESSION gross section (Also see Specs. A-8c to A-10c)	A-7c	Columns		13.5	$\frac{L}{r} = 11$	$14.4 - 0.080 L/r$	$\frac{L}{r} = 80$	$\frac{51,000}{(L/r)^2}$
	COMPRESSION in components of columns (Also see Spec. A-7c)	A-8c	Outstanding flanges and legs		13.5	$\frac{b}{t} = 6.0$	$16.5 - 0.50 b/t$	$\frac{b}{t} = 15$	$\frac{1,940}{(b/t)^2}$
		A-9c	Flat plates with both edges supported		13.5	$\frac{b}{t} = 19$	$16.5 - 0.160 b/t$	$\frac{b}{t} = 46$	$\frac{19,200}{(b/t)^2}$

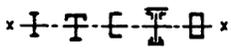
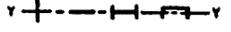
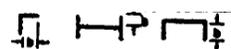
Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi					
		A-10c	Curved plates supported on both edges and walls of round or oval tubes 	13.5	$\frac{r}{t} = 16$	$15.4 - 0.47\sqrt{R/t}$	$\frac{R}{t} = 140$...	
COMPRESSION in Members Subjected to Bending Gross Section	COMPRESSION in extreme fibers of beams, gross section (Also see Specs. A-15c to A-18c)	A-11c	Single-web structural shapes and built-up sections bent about X-axis 	13.5	$L_b/r_y = 14$	$14.4 - 0.066 L_b/r_y$	$L_b/r_y = 96$	$\frac{74,000}{(L_b/r_y)^2}$	
		A-12c	Round or oval tubes 	17	$R_b/t = 16$	$16.0 - 0.064 R_b/t$	$R_b/t = 120$...	
		A-13c	Solid rectangular beams bent about X-axis 	19	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 12$	$24.8 - 0.48 \frac{d}{t} \sqrt{\frac{L_b}{d}}$	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 33$	$\frac{9,900}{(d/t)^2 L_b/d}$	
		A-14c	Rectangular tubes and box sections 	13.5	$\frac{L_b S_c}{I_y} = 49$	$14.4 - 0.128 \sqrt{\frac{L_b S_c}{I_y}}$	$\frac{L_b S_c}{I_y} = 2,510$	$\frac{20,000}{\frac{L_b S_c}{I_y}}$	
	COMPRESSION in components of beams, where component is under uniform compression (Also see Specs. A-11c to A-14c)	A-15c	Flat plates with one edge free and one edge supported 	13.5	$\frac{b}{t} = 6.8$	$16.5 - 0.44 \frac{b}{t}$	$\frac{b}{t} = 16$	$\frac{2,500}{(b/t)^2}$	
		A-16c	Flat plates with both edges supported 	13.5	$\frac{b}{t} = 19$	$16.5 - 0.160 \frac{b}{t}$	$\frac{b}{t} = 46$	$\frac{19,200}{(b/t)^2}$	
		A-17c	Flat plates with compression edge free and tension edge supported, bent about X-axis 	19	$\frac{b}{t} = 7.6$	$24.8 - 0.74 \frac{b}{t}$	$\frac{b}{t} = 22$	$\frac{4,200}{(b/t)^2}$	

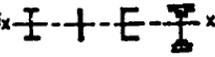
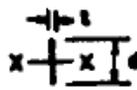
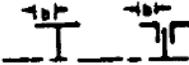
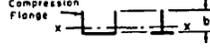
Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi				
		A-18c	Flat plates with both edges supported, bent about X-axis 	13.5	...	13.5	$h/t = 130$	$\frac{230,000}{(h/t)^2}$
SHEAR in webs of beams, and also in members subjected to torsion, gross section		A-19c	Unstiffened flat webs 	8.5	$h/t = 19$	$9.5 - 0.064 h/t$	$h/t = 79$	$\frac{33,000}{(h/t)^2}$

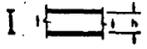
a. This value applies for a ratio of edge distance to rivet or bolt diameter of 2 or more. For smaller ratios, multiply this allowable stress by the ratio, (edge distance)/(twice the rivet or bolt diameter).

TABLE 3D

**ALLOWABLE STRESSES IN RIVETED OR BOLTED STRUCTURES OR IN WELDED STRUCTURES AT LOCATIONS FARTHER THAN 1.0 INCH FROM ANY WELD (BUILDING STRUCTURES)
6063-T5 BUILDING STRUCTURES NONWELDED**

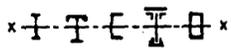
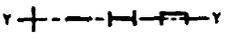
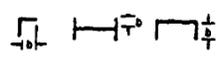
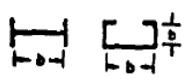
Type of Stress		Speci- fica- tion No.	Type of Member or Component		Allowable Stress, ksi				
TENSION, axial, net section		A-1d	Any tension member		9.5				
TENSION in extreme fibers of beams, net section		A-2d	Structural shapes, rectangular tubes, built-up members bent about X-axis		9.5				
		A-3d	Round or oval tubes		11				
		A-4d	Rectangular bars and plates, and outstanding flanges of shapes bent about Y-axis		13.5				
BEARING		A-5d	On rivets and bolts		15 ^(a)				
		A-6d	On milled surfaces and pins		10				
					Allowable Stress for Slenderness Less Than S₁, ksi	Slenderness Limit, S₁	Allowable Stress for Slenderness Between S₁ and S₂, ksi	Slenderness Limit, S₂	Allowable Stress for Slenderness Greater Than S₂, ksi
COMPRESSION in Columns Subjected to Axial Load, Gross Section	COMPRESSION gross section (Also see Specs. A-8d to A-10d)	A-7d	Columns		8.5	$\frac{L}{r} = 13$	$9.0 - 0.039 L/r$	$\frac{L}{r} = 100$	$\frac{51,000}{(L/r)^2}$
	COMPRESSION in components of columns (Also see Spec. A-7d)	A-8d	Outstanding flanges and legs		8.5	$\frac{b}{t} = 6.8$	$10.2 - 0.25 b/t$	$\frac{b}{t} = 19$	$\frac{1,940}{(b/t)^2}$
		A-9d	Flat plates with both edges supported		8.5	$\frac{b}{t} = 22$	$10.2 - 0.079 b/t$	$\frac{b}{t} = 58$	$\frac{19,200}{(b/t)^2}$

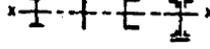
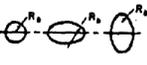
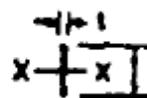
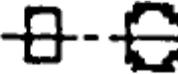
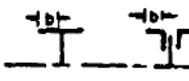
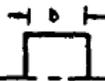
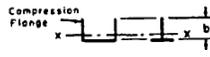
Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi				
		A-10d	Curved plates supported on both edges and walls of round or oval tubes 	8.5	$\frac{R}{t} = 12$	$9.2 - 0.198\sqrt{R/t}$	$\frac{R}{t} = 200$	...
COMPRESSION in Members Subjected to Bending Gross Section	COMPRESSION in extreme fibers of beams, gross section (Also see Specs. A-15d to A-18d)	A-11d	Single-web structural shapes and built-up sections bent about X-axis 	8.5	$L_b/r_y = 16$	$9.0 - 0.032 L_b/r_y$	$L_b/r_y = 120$	$\frac{74,000}{(L_b/r_y)^2}$
		A-12d	Round or oval tubes 	11	$R_b/t = 9.4$	$11.3 - 0.032 R_b/t$	$R_b/t = 140$	...
		A-13d	Solid rectangular beams bent about X-axis 	13.5	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 8.8$	$15.6 - 0.24 \frac{d}{t} \sqrt{\frac{L_b}{d}}$	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 44$	$\frac{9,900}{(d/t)^2 L_b/d}$
		A-14d	Rectangular tubes and box sections 	8.5	$\frac{L_b S_c}{I_y} = 65$	$9.0 - 0.062 \sqrt{\frac{L_b S_c}{I_y}}$	$\frac{L_b S_c}{I_y} = 3920$	$\frac{20,000}{\frac{L_b S_c}{I_y}}$
	COMPRESSION in components of beams, where component is under uniform compression (Also see Specs. A-11d to A-14d)	A-15d	Flat plates with one edge free and one edge supported 	8.5	$\frac{b}{t} = 7.7$	$10.2 - 0.22 \frac{b}{t}$	$\frac{b}{t} = 22$	$\frac{2,500}{(b/t)^2}$
		A-16d	Flat plates with both edges supported 	8.5	$\frac{b}{t} = 22$	$10.2 - 0.079 \frac{b}{t}$	$\frac{b}{t} = 58$	$\frac{19,200}{(b/t)^2}$
		A-17d	Flat plates with compression edge free and tension edge supported, bent about X-axis 	13.5	$\frac{b}{t} = 5.7$	$15.6 - 0.37 \frac{b}{t}$	$\frac{b}{t} = 28$	$\frac{4,200}{(b/t)^2}$

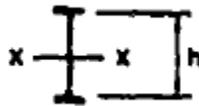
Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi				
		A-18d	Flat plates with both edges supported, bent about X-axis 	8.5	...	8.5	$h/t = 164$	$\frac{230,000}{(h/t)^2}$
SHEAR in webs of beams, and also in members subjected to torsion, gross section		A-19d	Unstiffened flat webs 	5.5	$h/t = 15$	$5.9 - 0.027 h/t$	$h/t = 103$	$\frac{33,000}{(h/t)^2}$

a. This value applies for a ratio of edge distance to rivet or bolt diameter of 2 or more. For smaller ratios, multiply this allowable stress by the ratio, (edge distance)/(twice the rivet or bolt diameter).

TABLE 5C
ALLOWABLE STRESSES ON SECTIONS WITHIN 1.0 INCH OF A WELD
(BUILDING STRUCTURES)
6063-T6 BUILDING STRUCTURES WELDED

Type of Stress		Speci- fica- tion No.	Type of Member or Component		Allowable Stress, ksi				
TENSION, axial, net section		I-1c	Any tension member		6.5				
TENSION in extreme fibers of beams, net section		I-2c	Structural shapes, rectangular tubes, built-up members bent about X-axis		6.5				
		I-3c	Round or oval tubes		7.5				
		I-4c	Rectangular bars and plates, and outstanding flanges of shapes bent about Y-axis		7.5				
BEARING		I-5c	On rivets and bolts		10 ^(b)				
		I-6c	On milled surfaces and pins		7				
					Allowable Stress for Slenderness Less Than S ₁ , ksi	Slenderness Limit, S ₁	Allowable Stress for Slenderness Between S ₁ and S ₂ , ksi	Slenderness Limit, S ₂	Allowable Stress for Slenderness Greater Than S ₂ , ksi
COMPRESSION in Columns Subjected to Axial Load, Gross Section	COMPRESSION ^(a) gross section (Also see Specs. I-8c to I-10c)	I-7c	Columns ^(a)		6.5	...	6.5	$\frac{L}{r} = 88$	$\frac{51,000}{(L/r)^2}$
	COMPRESSION in components of columns (Also see Spec. I-7c)	I-8c	Outstanding flanges and legs		6.5	$\frac{b}{t} = 4.4$	$\frac{13.6}{\sqrt{b/t}}$	$\frac{b}{t} = 27$	$\frac{1,940}{(b/t)^2}$
		I-9c	Flat plates with both edges supported		6.5	...	6.5	$\frac{b}{t} = 54$	$\frac{19,200}{(b/t)^2}$

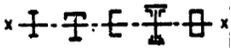
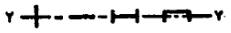
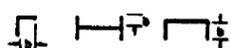
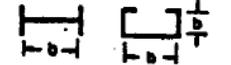
Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi				
		I-10c	Curved plates supported on both edges and walls of round or oval tubes 	6.5	$\frac{R}{t} = 12$	$\frac{12.0}{(R/t)^{1/4}}$	$\frac{R}{t} = 125$	...
COMPRESSION in Members Subjected to Bending Gross Section	COMPRESSION (a) in extreme fibers of beams, gross section (Also see Specs. I-15c to I-18c)	I-11c	Single-web structural shapes and built-up sections bent about X-axis ^(a) 	6.5	...	6.5	$L_b/r_y = 107$	$\frac{74,000}{(L_b/r_y)^2}$
		I-12c	Round or oval tubes 	7.5	$R_b/t = 12$	$\frac{13.9}{(R_b/t)^{1/4}}$	$R_b/t = 125$	...
		I-13c	Solid rectangular beams bent about X-axis 	7.5	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 11$	$\frac{24.3}{[(d/t)^2 L_b/d]^{1/4}}$	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 55$	$\frac{9,900}{(d/t)^2 L_b/d}$
		I-14c	Rectangular tubes and box sections ^(a) 	6.5	...	6.5	$\frac{L_b S_c}{I_y} = 3080$	$\frac{20,000}{\frac{L_b S_c}{I_y}}$
	COMPRESSION in components of beams, where component is under uniform compression (Also see Specs. I-11c to I-14c)	I-15c	Flat plates with one edge free and one edge supported 	6.5	$\frac{b}{t} = 4.8$	$\frac{14.2}{\sqrt{b/t}}$	$\frac{b}{t} = 31$	$\frac{2,500}{(b/t)^2}$
		I-16c	Flat plates with both edges supported 	6.5	...	6.5	$\frac{b}{t} = 54$	$\frac{19,200}{(b/t)^2}$
		I-17c	Flat plates with compression edge free and tension edge supported, 	7.5	$\frac{b}{t} = 6.9$	$\frac{19.6}{\sqrt{b/t}}$	$\frac{b}{t} = 36$	$\frac{4,200}{(b/t)^2}$

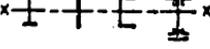
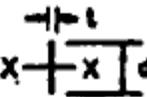
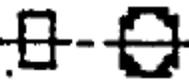
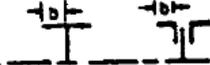
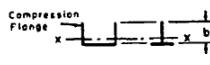
Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi					
	I-11c to I-14c)		bent about X-axis						
		I-18c	Flat plates with both edges supported, bent about X-axis		6.5	...	6.5	$h/t = 188$	$\frac{230,000}{(h/t)^2}$
SHEAR in webs of beams, and also in members subjected to torsion, gross section		I-19c	Unstiffened flat webs		4	...	4	$h/t = 91$	$\frac{33,000}{(h/t)^2}$

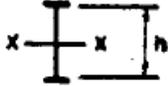
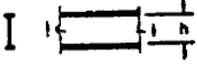
a. The allowable stresses for columns, single web beams and rectangular tubes and box sections apply to members supported at both ends and welded at the ends only. See Specification I-26 for allowable stresses in these members with welds at locations other than the ends and in cantilever columns and

b. This value applies for a ratio of edge distance to rivet or bolt diameter of 2 or more. For smaller ratios, multiply this allowable stress by the ratio, (edge distance)/(twice the rivet or bolt diameter)

TABLE 5D
ALLOWABLE STRESSES ON SECTIONS WITHIN 1.0 INCH OF A WELD
(BUILDING STRUCTURES)
6063-T5 BUILDING STRUCTURES WELDED

Type of Stress		Speci- fica- tion No.	Type of Member or Component		Allowable Stress, ksi				
TENSION, axial, net section		I-1d	Any tension member		6.5				
TENSION in extreme fibers of beams, net section		I-2d	Structural shapes, rectangular tubes, built-up members bent about X-axis		6.5				
		I-3d	Round or oval tubes		7.5				
		I-4d	Rectangular bars and plates, and outstanding flanges of shapes bent about Y-axis		7.5				
BEARING		I-5d	On rivets and bolts		10 ^(b)				
		I-6d	On milled surfaces and pins		7				
					Allowable Stress for Slenderness Less Than S ₁ , ksi	Slenderness Limit, S ₁	Allowable Stress for Slenderness Between S ₁ and S ₂ , ksi	Slenderness Limit, S ₂	Allowable Stress for Slenderness Greater Than S ₂ , ksi
COMPRESSION in Columns Subjected to Axial Load, Gross Section	COMPRESSION (^(a) gross section (Also see Specs. I-8d to I-10d)	I-7d	Columns ^(a)		6.5	$\frac{L}{r} = 64$	$9.0 - 0.039 \frac{L}{r}$	$\frac{L}{r} = 100$	$\frac{51,000}{(L/r)^2}$
	COMPRESSION in components of columns (Also see Spec. I-7d)	I-8d	Outstanding flanges and legs		6.5	$\frac{b}{t} = 4.4$	$\frac{13.6}{\sqrt{b/t}}$	$\frac{b}{t} = 27$	$\frac{1,940}{(b/t)^2}$
		I-9d	Flat plates with both edges supported		6.5	$\frac{b}{t} = 47$	$10.2 - 0.079 \frac{b}{t}$	$\frac{b}{t} = 58$	$\frac{19,200}{(b/t)^2}$

Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi				
		I-10d	Curved plates supported on both edges and walls of round or oval tubes 	6.5	$\frac{R}{t} = 12$	$\frac{12.0}{(R/t)^{1/4}}$	$\frac{R}{t} = 125$	...
COMPRESSION in Members Subjected to Bending Gross Section	COMPRESSION (^a) in extreme fibers of beams, gross section (Also see Specs. I-15d to I-18d)	I-11d	Single-web structural shapes and built-up sections bent about X-axis(^a) 	6.5	$L_b/r_y = 78$	$9.0 - 0.032L_b/r_y$	$L_b/r_y = 120$	$\frac{74,000}{(L_b/r_y)^2}$
		I-12d	Round or oval tubes 	7.5	$R_b/t = 12$	$\frac{13.9}{(R_b/t)^{1/4}}$	$R_b/t = 125$	...
		I-13d	Solid rectangular beams bent about X-axis 	7.5	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 11$	$\frac{24.3}{[(d/t)^2 L_b/d]^{1/4}}$	$\frac{d}{t} \sqrt{\frac{L_b}{d}} = 55$	$\frac{9,900}{(d/t)^2 L_b/d}$
		I-14d	Rectangular tubes and box sections(^a) 	6.5	$\frac{L_b S_c}{I_y} = 1620$	$9.0 - 0.062 \sqrt{\frac{L_b S_c}{I_y}}$	$\frac{L_b S_c}{I_y} = 3920$	$\frac{20,000}{\frac{L_b S_c}{I_y}}$
	COMPRESSION in components of beams, where component is under uniform compression (Also see Specs. I-11d to I-14d)	I-15d	Flat plates with one edge free and one edge supported 	6.5	$\frac{b}{t} = 4.8$	$\frac{14.2}{\sqrt{b/t}}$	$\frac{b}{t} = 31$	$\frac{2,500}{(b/t)^2}$
		I-16d	Flat plates with both edges supported 	6.5	$\frac{b}{t} = 47$	$10.2 - 0.079b/t$	$\frac{b}{t} = 50$	$\frac{19,200}{(b/t)^2}$
	COMPRESSION in components of beams where component is under bending in its own plane, (Also see Specs.	I-17d	Flat plates with compression edge free and tension edge supported, 	7.5	$\frac{b}{t} = 6.9$	$\frac{19.6}{\sqrt{b/t}}$	$\frac{b}{t} = 30$	$\frac{4,200}{(b/t)^2}$

Type of Stress		Speci- fica- tion No.	Type of Member or Component	Allowable Stress, ksi					
	I-11d to I-14d)		bent about X-axis						
		I-18d	Flat plates with both edges supported, bent about X-axis		6.5	...	6.5	$h/t = 188$	$\frac{230,000}{(h/t)^2}$
SHEAR in webs of beams, and also in members subjected to torsion, gross section		I-19d	Unstiffened flat webs		4	$h/t = 70$	$5.9 - 0.027h/t$	$h/t = 103$	$\frac{33,000}{(h/t)^2}$

a. The allowable stresses for columns, single web beams and rectangular tubes and box sections apply to members supported at both ends and welded at the ends only. See Specification I-26 for allowable stresses in these members with welds at locations other than the ends and in cantilever columns and

b. This value applies for a ratio of edge distance to rivet or bolt diameter of 2 or more. For smaller ratios, multiply this allowable stress by the ratio, (edge distance)/(twice the rivet or bolt diameter).

d. Cross sections with part of area affected by heat of welding

If less than 15 percent of the area of a given cross section lies within one inch of a weld, the effect of the welds can be neglected and allowable stress for that cross section can be calculated by the formulas in tables 3C or 3D. If the area of a cross section that lies within one inch of a weld is between is percent and 100 percent of the total area of the cross section, the allowable stress shall be calculated by the following formula:

$$f_{pw} = f_n - \frac{A_w}{A} (f_a - f_w)$$

(4)

where f_{pw} = allowable stress on cross section, part of whose area lies within one inch of a weld, ksi

f_n = allowable stress for same cross section if there were no welds present (see table 3C or 3D), ksi

f_w = allowable stress for same cross section if entire area lies within one inch of a weld (see table 5C or 5D), ksi

A = net area of cross section of a tension member or tension flange of a beam, or gross area of cross section of a compression member or compression flange of a beam, sq. in. (A beam flange is considered to consist of that portion of the member farther than $2c/3$ from the neutral axis, where c is the distance from the neutral axis to the extreme fiber).

A_w = area within area A that lies within one inch of weld, sq. in.

e. Columns and single web beams with welds at locations other than ends and cantilever columns and single web beams.

The allowable stresses in specifications 1-7 and 1-8 apply to members supported at both ends with welds at the ends only (not farther from the supports than 0.05 of the length of the column or beam). For cantilever columns or beams and for columns and beams having welds at locations other than the ends, the allowable stress shall be determined from the following:

Members with welds affecting the entire cross section:

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$$f_n = 13.3$$

$$13.3 \geq f_n \geq 1.9$$

$$f_n \leq 1.9$$

$$f_w = 6.5$$

$$6.7$$

$$f_w = \frac{6.7}{\sqrt{14.4 - f_n}}$$

$$f_w = f_n$$

(5)

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$$\begin{aligned}
& f_n > 8.5 \\
& 8.5 \geq f_n \geq 1.7 \\
& f_n \leq 1.7 \\
& f_w = 6.5 \\
& \quad 4.7 \\
& f_w = \frac{4.7}{\sqrt{9.0 - f_n}} \\
& f_w = f_n
\end{aligned}$$

(6)

where f_n and f_w are as previously defined.

Members with welds affecting less than the entire cross section:

The allowable stress shall be determined from Eq. 4, where the value of f_w is given by Eqs. 5 or 6.

f. Single web beams and girders

The simplified formulas of tables 3 and 5 give very conservative values of allowable stress for values of L_b/r_y exceeding about 50. If the designer wishes to compute more precise values of allowable compressive stress for single web beams and girders, the value of r_y in specification A-8 may be replaced by an "effective r_y " given by the following formula

$$\text{Effective } r_y = \frac{1}{1.7} \sqrt{\frac{I_y d}{S_c} \sqrt{1 + 0.152 \frac{J}{I_y} \left(\frac{L_b}{d}\right)^2}}$$

(7)

where d = depth of beam, in.

I_y = moment of inertia of beam about axis parallel to web, in.⁴

J = torsion constant of beam, in.⁴

S_c = section modulus of beam for compression flange, in.³

g. In applications where it is conventional practice to increase allowable stresses for certain types (If loads, such as wind loads, the allowable stresses in these specifications should be increased in the same proportion as are the allowable stresses in accepted specifications for steel structures. (See table 3C.)

TABLE 4C
ALLOWABLE SHEAR STRESSES IN RIVETS AND BOLTS
(Building Structures of 6063-T6)

Specification Number	Description of Rivet or Bolt	Allowable Stress, ksi	
		Shear on Effective Shear Area	Tension on Root Area
A-20c	6053-T61 rivets, cold driven	8.5	...
A-21c	6061-T43 rivets, driven at temperatures of from 990°F to 1050°F	9	...
A-22c	2024 T 4 bolts	16 _a	26

a. This allowable shear stress applies to either turned bolts in reamed holes or unfinished bolts in 1/16-inch oversize holes.
(See table 5C)

TABLE 6C
ALLOWABLE SHEAR STRESSES IN FILLET WELDS
(Building Structures of 6063-T6)

Specification Number	Filler Alloy	Allowable Shear Stress _a , ksi	
		Transverse Shear in Single Fillet Welds or Longitudinal Shear _b	Transverse Shear in Double Fillet Welds _b
I-20c	5356	6.5 _c	6.5 _c
	5556		
I-21c	4043	5	6.5 _c

a. Shear stress is considered to be equal to the load divided by the throat area, regardless of direction of loading.
b. Single fillet welds in transverse shear may be treated as double fillet welds in joints so designed as to prevent local bending of the parts adjacent to the fillet weld.
c. These values are controlled by the shear strength of the parent material; all other values are controlled by the strength of the filler metal.
(See table 3D.)

TABLE 4D
ALLOWABLE SHEAR STRESSES IN RIVETS AND BOLTS
(Building Structures of 6063-T5)

Specification Number	Description of Rivet or Bolt	Allowable Stress, ksi	
		Shear on Effective Shear Area	Tension on Root Area
A-20d	6053-T61 rivets, cold driven	8.5	...
A-21d	6061-T43 rivets, driven at temperatures of from 990°F to 1050°F	9	..
A-22d	2024 T 4 bolts	16 _a	26

a. This allowable Shear stress applies to either turned bolts in reamed holes or unfinished bolts in 1/16 in. oversize holes.
(See table 5D.)

TABLE 6D
ALLOWABLE SHEAR STRESSES IN FILLET WELDS
(Building Structures of 6063-T5)

Specification Number	Filler Alloy	Allowable Shear Stress ^a , ksi	
		Transverse Shear in Single Fillet Welds or Longitudinal Shear ^b	Transverse Shear in Double Fillet Welds ^b
I-20d	5356	6.5 ^c	6.5 ^c
	5556		
I-21d	4043	5	6.5 ^c

- a. Shear stress is considered to be equal to the load divided by the throat area, regardless of direction of loading.
- b. Single fillet welds in transverse shear may be treated as double fillet welds in joints so designed as to prevent local bending of the parts adjacent to the fillet weld.
- c. These values are controlled by the shear strength of the parent material; all other values are controlled by the strength of the filler metal.

Sub-Article 5. Bearing Values of Soils

§C26-376.0 Test Pits or Borings.-

a. Except as otherwise provided in this title, applications for permits for new structures, and where required, applications for alterations in structures erected before January first, nineteen hundred thirty-eight, shall contain a statement of the character of the soil strata supporting the foundations or footings. Such applications shall include the records of borings or test pits which shall show the nature of the soil in at least one location in every twenty-five hundred square feet of building area. The borings or test pits shall be carried sufficiently into good bearing material to establish its character and thickness. For structures more than one story in height except dwellings not more than two stories in height, or for structures having an average area load exceeding one thousand pounds per square foot, there shall be at least one boring in every ten thousand square feet of building area carried to a depth of one hundred feet below the curb or to a depth which shows twenty-five continuous feet of material of class 10 or better, as classified in section C26-377.0, below the deepest part of the excavation of the proposed structure, or five feet into ledge rock.

For structures having an average area load in excess of two thousand pounds per square foot, supported on rock, either directly or by piles to rock, or piers to rock, all borings shall be carried to a depth of at least five feet below the surface of the rock except where ledge rock is completely uncovered. Such structures not bearing on rock shall have at least one boring in each ten thousand square feet of building area carried to a depth of one hundred feet below curb, or five feet into ledge rock.

Records of core borings into rock shall show in all cases the percentage of rock core recovered.

The average area load is the sum of all dead loads and the reduced live loads of the building, as specified in section C26-348.0, divided by the area of the building at the ground level.

Such records shall be certified by a licensed professional engineer or a licensed architect. Samples of the different strata encountered in such borings or test pits, representing the natural state in the ground of such strata, shall be available for the inspection of the superintendent.

b. It shall be unlawful to take washed or bucket samples and all samples, except those of rock shall be so bottled as to protect them against evaporation. The number, location and depth of such pits and borings, together with the method used in making and reporting them, shall be satisfactory to the superintendent.

§C26-377.0 Presumptive Bearing Capacities of Soils.-

a. Satisfactory bearing materials shall be ledge rock in its natural bed, natural deposits of gravel, sand, compact inorganic silt, or clay or any combination of these materials. These bearing materials shall not contain an appreciable amount of organic matter or other unsatisfactory material, nor shall they be underlaid by layers of such unsatisfactory materials of appreciable thickness.

b. Fill material, mud, muck, peat, organic silt, loose inorganic silt, and soft clay shall be considered as unsatisfactory bearing materials and shall be treated as having no presumptive bearing value.

c. The maximum allowable presumptive bearing values for satisfactory bearing materials shall, except for pile foundations (see section C26-405.0, c), in the absence of satisfactory load tests or other evidence, be those established in the following classification:

Classification of Supporting Soils

Class	Material	Maximum allowable presumptive bearing values in tons per square foot
1	Hard sound rock	60
2	Medium hard rock	40
3	Hardpan overlaying rock	12
4	Compact gravel and boulder-gravel formations; very compact sandy gravel	10
5	Soft rock	8
6	Loose gravel and sandy gravel; compact sand and gravelly sand; very compact sand-inorganic silt soils	6
7	Hard dry consolidated clay	5
8	Loose coarse to medium sand; medium compact fine sand	4
9	Compact sand-clay soils	3
10	Loose fine sand; medium compact sand-inorganic silt soils	2
11	Firm or stiff clay	1.5
12	Loose saturated sand-clay soils; medium soft clay	1
Explanation of Terms		
Compaction Related to Spoon Blows; Sand		
Descriptive Term	Blows/Foot	Remarks
Loose	15 or less	These figures approximate for medium sand, 2½-inch spoon, 300-pound hammer, 18-inch fall. Coarser soil requires more blows, finer material fewer blows.
Compact	16 to 50	
Very Compact	50 or more	
Consistency Related to Spoon Blows; Mud, Clay, Etc.		
Descriptive Term	Blows/Foot	Remarks
Very soft	push to 2	Molded with relatively slight finger pressure.
Soft	3 to 10	
Stiff	11 to 30	Molded with substantial finger pressure; might be removed by spading.
Hard	30 or more	Not molded by fingers, or with extreme difficulty; might require picking for removal.

EXPLANATION OF TERMS

Supplementary Tables for 2" Spoons Compaction Related to Spoon Blows Supplement to Building Code

FOR MEDIUM SAND		
Descrip. Term	Blows per ft.	
Loose	15 or less	These figures approximate for 2" spoon, 148 pound hammer, 30 inch fall.
Med. Compact	16 – 30	
Compact	30 – 50	
Very Compact	50 or more	
Descrip. Term	Blows per ft.	
Loose	10 or less	These figures approximate for 2" spoon, 300 pound hammer, 18 inch fall.
Med. Compact	11 – 25	
Compact	26 – 45	
Very Compact	45 or more	
Descrip. Term	Blows per ft.	
Loose	25 or less	These figures approximate for 2" spoon, 150 pound hammer, 18 inch fall.
Med. Compact	25 – 45	
Compact	45 – 65	
Very Compact	65 or more	
FOR CLAY		
Descrip. Term	Blows per ft.	
Very soft	Push to 3	These figures approximate for 2" spoon, 148 pound hammer, 30 inch fall.
Soft	4 to 12	
Stiff	12 to 35	
Hard	35 or more	
Descrip. Term	Blows per ft.	
Very soft	Push to 2	These figures approximate for 2" spoon, 300 pound hammer, 18 inch fall.
Soft	3 to 10	
Stiff	10 to 25	
Hard	25 or more	
Descrip. Term	Blows per ft.	
Very soft	Push to 5	These figures approximate for 2" spoon, 150 pound hammer, 18 inch fall.
Soft	5 to 15	
Stiff	15 to 40	
Hard	40 or more	

Coarser soil requires more blows; finer material fewer blows. A variation of 10 percent in the weight of hammer will not materially affect values in tables.

The use of any specific size of spoon, weight and fall of hammer is not mandatory in the Code. However, any other size of spoon or weight of hammer exceeding the 10 percent variation from weight of hammer specified in above tables shall not be accepted until sufficient data has been submitted for investigation and approval.

Soil Sizes			
Descriptive Term	Pass Sieve Number	Retained Sieve Number	Size Range
Clay	200	Hydrometer analysis	.006 mm.
Silt	200		.006 to .074 mm.
Fine sand	65	200	.074 to .208 mm.
Medium sand	28	65	.208 to .589 mm.
Coarse sand	8	28	.589 to 2.362 mm.
Gravel	-	8	2.362 mm.
Pebble	-	-	2.362 mm. to 2½"
Cobble	-	-	2½" to 6"
Boulder	-	-	6"

Hard sound rock is rock such as Fordham gneiss, Ravenswood gneiss and trap rock, in sound condition, with some cracks allowed.

Medium hard rock is rock such as Inwood limestone, Manhattan schist and massive serpentine with some cracks allowed and slight weathering along cracks.

Soft rock is rock such as shale, decomposed serpentine, decomposed schist or decomposed gneiss, with some disintegration and softening and with considerable cracks allowed.

Hardpan overlying rock is a natural deposit of a thoroughly cemented mixture of sand and pebbles, or of sand, pebbles and clay, with or without a mixture of boulders and difficult to remove by picking.

d. When it is shown by borings, or otherwise that materials of varying bearing values must be used for the support of structures:

1. The bearing value allowable for footings on the stronger material shall be unchanged;
2. The bearing value allowable for footings on the weaker material shall be unchanged, provided the weaker material is not more than two classes below that of the stronger material as established in this section, but
3. If the weaker material is ranked more than two classes below that of the stronger material as established in this section, the bearing value allowable for footings on the weaker material shall be reduced by a percentage equal to five times the number of classes it is below the stronger material in ranking.

(7.5.3.1). §C26-378.0 Soil Tests.-

a. When soil tests are required.-Where there is doubt as to the character of the soil or should application for permission to impose on the soil loads in excess of those specified in section C26-377.0 a static load test shall be made in accordance with the rules of the board and at the expense of the owner of the proposed structure. The superintendent shall be duly notified of any such test in order that he may be present either in person or by representative. A complete record of such test shall be filed with the department.

b. Procedure for Soil Tests.-In conducting tests to determine the safe sustaining power of the soil, the following regulations shall govern:

1. The soil shall be tested at one or more places and at such level or levels as the conditions may determine or warrant.
2. All tests shall be made under the supervision of the superintendent or his representative.
3. For bearing materials of classes 1 to 4 inclusive as specified in section C26-377.0, the loaded area shall be at least one square foot and for other classes at least four square feet. For materials of classes 4 to 12 inclusive, the loaded area shall be the full size of the pit

and shall be at such depth that the ratio of the width of the loaded area to its depth below the immediate adjacent ground surface is the same or greater than the larger of the following two values:

- (a). Ratio of the width of any footing to its depth below the immediately adjacent ground surface.
 - (b). Ratio of the width of the entire foundation or group of footings to its depth below the average surrounding ground surface.
4. When loading tests are made on bearing materials of classes 7, 11 and 12, suitable methods shall be used to prevent evaporation from the materials being tested.
 5. Before any test is made, the proposed testing apparatus and specifications of the procedure shall be approved by the superintendent.
 6. The loading of the soil shall proceed as follows:
 - (a). The loads shall be applied by direct weight or by means of a hydraulic jack pressure that is automatically maintained constant.
 - (b). The load per square foot which it is proposed to impose on the soil shall be first applied and allowed to remain undisturbed and readings taken at least once every twenty-four hours in order to determine the rate of settlement. The applied load shall remain until there has been no settlement for a period of twenty-four hours.
 - (c). After the requirements of class (b) of this sub-division are met, an additional fifty percent excess load shall be applied in increments not exceeding twenty-five percent of the design load. At least four hours shall elapse between application of successive increments. The total load shall be allowed to remain undisturbed until no settlement occurs during a period of twenty-four hours.
 - (d). Measurements of settlement shall be accurate to one thirty-second inch and shall be taken and recorded every hour during the first six hours after the application of each increment and at least once every twelve hours thereafter. Settlement readings shall be referred to a bench mark established at a sufficient distance from the test to be unaffected by it.

§C26-379.0 Determination of Results of Soil Tests.-

1. The gross settlement under the proposed safe load upon bearing materials of classes 1 to 10 inclusive shall not exceed one-half inch and the total gross settlement after the fifty percent excess load is applied shall not exceed one inch.
2. Whenever the proposed foundation rests on or is underlaid by a stratum of compressible soil ranking below class 10 as classified in section C26-377.0, c, effective measures shall be used to reduce the magnitude and unequal character of the settlement to be expected as a result of the consolidation of such stratum under the stresses imposed by the foundation loads, in which case a report shall be submitted by a licensed professional engineer experienced in soil testing and analysis, to the superintendent establishing the effectiveness of such measures, based upon laboratory soil tests on undisturbed samples of the compressible soils of a satisfactory quality and upon foundation analysis to determine to the satisfaction of the superintendent that the probable total magnitude, distribution and time-rate of settlement to be expected for the proposed structure will not be excessive.