CHAPTER XIV—MASONRY CONSTRUCTION

SECTION 1401—GENERAL

(a) All masonry construction shall conform to the provisions of this chapter and other applicable sections of this Code.

(b) In all cases masonry shall be of adequate thickness, strength and proportions to support all superimposed loads within the allowable working stresses prescribed.

(c) All masonry materials are required to meet the specifications as outlined in Section 1402. If the Building Official has reason to doubt the materials meeting the applicable specification he may require tests on the materials.

(d) Masonry units may be re-used when clean, whole and conforming to the other requirements of this chapter, except that the allowable working stresses shall be 50 percent of those permitted for new masonry units.

(e) The wall thickness and other specified dimensions are nominal dimensions. The actual masonry or wall dimensions may vary from the nominal dimensions by not more than one-half (½) inch.

SECTION 1402—MATERIALS

1402.1—BRICK

Brick of clay, shale, sand-lime or concrete shall be of a quality at least equal to that required by ASTM Specifications (C62-62) for clay or shale building brick; (C73-51) for sand-lime brick; or (C55-64T) for concrete building brick. When in contact with the ground, such as foundation work, or when used in retaining walls, the brick shall be of at least Grade SW for clay or shale or sand-lime brick, or Grade A for concrete brick. When exposed to the weather above ground the brick shall be of at least Grade MW for clay or shale or sand-lime brick, or Grade A for concrete brick.

1402.2—STRUCTURAL CLAY TILE

Structural clay tile shall be of a quality at least equal to that required by ASTM "Standard Specifications for Structural Clay Load-Bearing Wall Tile (C34-62) Grade LB when used for bearing walls or piers or Grade LBX when exposed to the weather or soil, or equal to the "Standard Specifications for Structural Clay Non-Load-Bearing Tile" (C56-62) when used for interior non-load-bearing purposes, or equal to "Standard Specifications for Structural Clay Floor Tile" (C57-57) when used as a structural unit in combination reinforced floor or roof construction. (Tile meeting ASTM (C34-62) Grade LB may be used in on-grade floors.)

1402.3—CERAMIC AND SALT GLAZED STRUCTURAL CLAY FACING TILE OR BRICK

All glazed masonry building units shall conform to the applicable requirements for solid or hollow clay masonry units of Sections 1402.1 and 1402.2.

1402.4—HOLLOW AND SOLID CONCRETE MASONRY UNITS

(a) Hollow concrete masonry units shall be of a quality at least equal to that required by ASTM "Standard Specifications for Hollow Load-

Bearing Concrete Masonry Units" (C90-64T) or "Standard Specifications for Solid Load-Bearing Concrete Masonry Units" (C145-64T) when used for bearing walls or piers or when in contact with the ground or exposed to the weather, or equal to "Standard Specifications for Hollow Non-Load-Bearing Concrete Masonry Units" (C129-64T) when used for non-bearing purposes and not exposed to the weather.

(b) Structural concrete filler-block or floor tile when included in strength calculations in ribbed floor construction shall have webs and shells not less than one inch thick and shall develop an average compressive strength on the net area not less than that of the rib concrete.

1402.5—CAST STONE

Cast stone shall be of a quality at least equal to that required by "Specifications for Cast Stone" (704-44) of the American Concrete Institute.

1402.6—PLAIN CONCRETE

Cast-in-place concrete construction reinforced only for shrinkage or temperature changes shall be classed as plain concrete. Plain concrete, other than fill, shall conform to the requirements for reinforced concrete (Chapter XVI) and have a minimum ultimate compressive strength at 28 days of 2,000 psi.

1402.7—NATURAL STONE

Natural stone for masonry shall be sound and free from loose or friable inclusions; and shall meet the strength, fire-resistance, durability, and resistance to impact for the proposed use. The Building Official may require satisfactory written evidence to this effect.

1402.8—ARCHITECTURAL TERRA COTTA AND CERAMIC VENEER

All architectural terra cotta and ceramic veneer shall have a strong homogenous body and shall conform to the applicable requirements of Section 1402.2. All units of the anchor type shall have the necessary anchor holes and shall be so formed as to engage properly with the supporting structure. All units of the adhesion type shall have keyed or scored back surfaces.

1402.9—GYPSUM MASONRY UNITS

Gypsum partition tile or block shall be of a quality at least equal to that required by ASTM "Standard Specifications for Gypsum Partition Tile or Block" (C52-54).

1402.10—STRUCTURAL GLASS BLOCK UNITS

Structural glass block shall comply with the provisions of Section 1413.

1402.11—MORTAR AND GROUT MATERIALS, PROPORTIONS AND WORKABILITY

(a) Mortar and its ingredients as delivered to the mason shall be of a quality at least equal to that required by ASTM "Tentative Specifications for Mortar for Unit Masonry" (C270-61T).

(b) Masonry cement shall be of a quality at least equal to that required by ASTM "Masonry Cement" (C91-60).

(c) The type of mortar delivered to the mason for any specific job shall be as required in 1402.12.

(d) Grout shall conform to the applicable requirements of ASTM "Specifications for Mortar and Grout for Reinforced Masonry" (C476).

(e) The volume of aggregate in mortar shall be at least two and one-quarter times but not more than three times the volume of cementitious material.

(f) Gypsum mortar shall be composed of one part of unfibered calcined neat gypsum to not more than three parts sand by weight. Only gypsum mortar shall be used with gypsum tile and block units.

1402.12—TYPES OF MORTAR REQUIRED

Masonry shall be laid in mortar of the types specified in Tables 1, 2 and 3.

TABLE 1—TYPES OF MORTAR

Type	Average Compressive Strength 2 inch cubes at 28 days, psi
M	2500
S	1800
N	750
O	350

TABLE 2—MORTAR PROPORTIONS BY VOLUME*

Mortar Type	Portland Cement Cu. Ft.	Masonry Cement Cu. Ft.	Hydrated Lime or Lime Putty Cu. Ft.	Aggregate Measured in Damp Loose Condition Cu. Ft.
M	1	None	¼	Not less than 2¼ and not more than 3 times the sum of of the volumes of cement and lime used.
	1	1- Type 2	None	
S	1	None	Over ¼ to ½	
	½	1- Type 2	None	
N	1	None	Over ½ to 1	
	None	1- Type 2	None	
O	1	None	Over 1 to 2	
	None	1- Type 1 or Type 2	None	

*For the purpose of these specifications, the weight of one cubic foot of the respective materials used shall be considered to be as follows:

Portland Cement ..... 94 pounds
Masonry Cement ..... weight printed on bag
Hydrated Lime ..... 40 pounds
Lime Putty (Quicklime) ..... 80 pounds
Sand, damp and loose ..... 80 pounds of dry sand

TABLE 3

TYPES OF MORTAR REQUIRED

Type of Masonry	Types of Mortar Permitted
Foundations: (below grade masonry)	
Footings	M or S
Walls of Solid Units	M, S or N
Walls of Hollow Units	M or S
Hollow Walls	M or S
Masonry Other Than Foundation Masonry	
Piers of Solid Masonry	M, S or N
Piers of Hollow Units	M or S
Walls of Solid Masonry	M, S, N or O
Walls of Hollow Masonry	M, S or N
Hollow Walls and Cavity Walls	
(a) Design Wind Pressure Exceeds 20 psf.	M or S
(b) Design Wind Pressure 20 psf or less.	M, S or N
Glass Block Masonry	M, S or N
Non-Bearing Partition and Fireproofing	M, S, N, O or Gypsum
Gypsum Partition Tile or Block	Gypsum
Fire Brick	Refractory Air Setting Mortar
Masonry Other Than Above	M, S or N

1402.13—CERAMIC TILE

(a) Ceramic tile units shall be as defined in ASTM C242-60T and shall be of a quality at least equal to that required by Federal Specification SS-T-308b and shall be graded and marked in conformance with United States Department of Commerce Simplified Practice Recommendation R61-61.

(b) Ceramic Tile set in cement mortar shall be installed in accordance with American Standard Specifications A108.1, A108.2 and A108.3-1958 with mortar mixes as specified therein for particular uses.

(c) Organic adhesives to be used in installing ceramic tile shall conform with requirements of U. S. Department of Commerce, Commercial Standard 181-52.

(d) Ceramic tile set in dry-set mortar shall be installed in accordance with American Standard Specification A108.5-1960 and the dry-set mortar shall conform with requirements of American Standard Specifications for Dry-Set Portland Cement Mortar, A118.1-1959.

1402.14—METAL ANCHORS AND TIES

Cross wire or metal anchors which serve as ties in multi-wythe masonry walls shall be of corrosion-resistant metal or shall be coated with a corrosion-resistant metal, or other approved coating. Where corrosion-resistant anchors, or ties are called for, they shall be copper-coated or zinc-coated or of other noncorrodible metal having equivalent corrosion-resistant qualities.

(a) Zinc coatings on iron or steel shall conform to ASTM Specification A153-65 Class B-1, B-2 or B-3.

(b) Zinc coatings on wire shall conform to ASTM Specification A116-65 Class 1.

(c) Copper coated wire shall conform to ASTM Specification B277-65 Grade 30 HS.

All wire used as anchors, joint reinforcement or ties shall conform to ASTM Specification A82-65. Steel bar reinforcement shall conform to ASTM Specification A15-65.

1402.15—PREFABRICATED JOINT REINFORCEMENT

Prefabricated wire reinforcement for embedment in horizontal mortar joints shall consist of two or more smooth or deformed longitudinal wires weld connected to the cross wires. The distance between welded contacts of cross wires with each longitudinal wire shall not exceed six inches and 16 inches respectively for smooth and deformed longitudinal wire. Longitudinal wires and cross wires shall be not less than No. 9 gage where used in ⅜ inch or thicker mortar joints and not less than No. 12 gage where used in thinner mortar joints. Cross wires shall be corrosion-resistant and shall be not less than No. 9 gage where joint reinforcement is used to bond the facing and backing of masonry or where joint reinforcement is used to bond cavity walls. The out-to-out spacing of longitudinal wires shall be such that the wires will be thoroughly embedded in the mortar joints as required in Section 11.13.

SECTION 1403—WORKING STRESSES

1403.1—GENERAL REQUIREMENTS

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

(b) The thickness of masonry walls shall be sufficient at all points to withstand all vertical and horizontal loads as specified in Chapter XII, Minimum Design Loads.

(c) Stresses shall be calculated on actual rather than nominal dimensions.

(d) The maximum allowable stresses in masonry shall not exceed those set out in this section, unless it can be determined by accepted engineering analysis that the design meets all safety requirements; see Section 1403.3.

1403.2—WORKING STRESSES IN UNREINFORCED MASONRY

Except as permitted in other sections of this Code, the compressive stresses in unreinforced masonry shall not exceed the values given in Table 4.

The eccentricity of vertical load and the effects of lateral load shall be considered.

TABLE 4

ALLOWABLE COMPRESSIVE STRESSES IN UNIT MASONRY

Construction; grade of unit	Allowable compressive stresses gross cross-sectional area (except as noted)			
	Type M Mortar	Type S Mortar	Type N Mortar	Type O Mortar
Solid masonry of brick and other solid units of clay or shale; sand-lime or concrete brick:	psi	psi	psi	psi
8,000 plus, psi	400	350	300	200
4,500 to 8,000, psi	250	225	200	150
2,500 to 4,500, psi	175	160	140	110
1,500 to 2,500, psi	125	115	100	75
Grouted[1] solid masonry of brick and other solid units of clay or shale; sand-lime or concrete brick:				
4,500 plus, psi	350	275	200	—
2,500 to 4,500, psi	275	215	155	—
1,500 to 2,500, psi	225	175	125	—
Solid masonry of solid concrete masonry units:				
Grade A	175	160	140	100
Grade B	125	115	100	75
Masonry of hollow units	85	75	70	—
Piers of hollow units, cellular spaces filled, as in Section 1405.6	105	95	90	—
Hollow walls (cavity or masonry bonded)[2]				
Solid units:				
Grade A or 2,500, psi plus	140	130	110	—
Grade B or 1,500 to 2,500, psi	100	90	80	—
Hollow units	70	60	55	—
Stone ashlar masonry:				
Granite	800	720	640	500
Limestone or Marble	500	450	400	325
Sandstone or cast stone	400	360	320	250
Rubble stone, coursed, rough or random	140	120	100	80

[1]See Section 1410.

[2]On gross cross-sectional area of wall minus area of cavity between wythes (leaves). The allowable compressive stresses for cavity walls are based upon the assumption that the floor loads bear upon but 1 of the 2 wythes. When hollow walls are loaded concentrically, the allowable stresses may be increased by 25 percent.

1403.3—HIGHER WORKING STRESSES

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

1403.4—ALLOWABLE STRESSES IN COMPOSITE WALLS

In composite walls or other structural members composed of different kinds or grades of masonry units or mortars, the maximum stress shall not exceed the allowable stress for the weakest of the units and mortars of which the wall or member is composed.

1403.5—ALLOWABLE STRESSES IN UNREINFORCED CONCRETE

The allowable stresses shall not exceed 25 percent for compression and 3 percent for tension in extreme fiber in flexure of the compressive strength of the concrete. When the ratio of height to thickness of structural members of plain concrete exceeds 10, the percentage for compressive stress shall be reduced proportionately to 18 percent for a ratio of height to thickness of 20.

1403.6—CONCENTRATED LOADS

(a) A fifty percent increase in the allowable working-stresses shown in Table 4 shall be permitted for concentrated loads meeting the bearing requirements of Section 1409.3 where such loads are supported upon not less than a 4-inch height of solid masonry units or hollow masonry units with the cells filled solidly with mortar or grout. The clear distance between the application of two adjacent concentrated loads on a wall shall be not less than the sum of the widths of the bearings or bearing plates.

(b) For piers and columns the bearing plate shall not exceed sixty percent of the cross-sectional area of the pier or column and the resultant reaction of all vertical and horizontal loads shall fall within the middle third of the member.

(c) Concentrated loads shall not be considered as distributed in masonry laid in stacked bond unless one continuous ¼-inch round reinforcing bar or its equivalent is placed in the horizontal bed joints for each 4 inches of wall thickness and spaced not less than 16 inches on centers vertically.

1403.7—ENGINEERED DESIGNS

Where the height, thickness and lateral support of masonry construction is determined by a structural analysis, the requirements in Section 1404 and 1405 may be waived in deference to design procedures and allowable stresses set for in "Recommended Building Code Requirements for Engineering Brick Masonry", SCPI May, 1966. The Building Official may require copy of structural analysis for his file. He may require the designer or other qualified person to supervise the work.

SECTION 1404—WALL THICKNESS

1404.1—GENERAL

The minimum thickness of all masonry bearing or non-bearing walls shall be sufficient to resist or withstand all vertical or horizontal loads required by this Code and the fire-resistance requirements set out in Chapter XXV. (See Section 1403.7.)

1404.2—THICKNESS OF BEARING WALLS

The minimum thickness of masonry bearing walls shall be at least 12 inches in thickness for the uppermost 35 feet of their height and shall be increased 4 inches in thickness for each successive 35 feet or fraction thereof measured downward from the top of the wall.

EXCEPTIONS:

(a) STIFFENED WALLS: Where solid masonry bearing walls are stiffened at distances not greater than 12 feet apart by masonry cross-walls or by reinforced concrete floors, they may be of 12-inch thickness for the uppermost 70 feet, measured downward from the top of the wall, and shall be increased 4 inches in thickness for each successive 70 feet or fraction thereof.

(b) TOP-STORY WALLS: The top-story walls of a building not exceeding 35 feet in height may be of 8-inch thickness provided it is not over 12 feet in height and the roof construction imparts no lateral thrust to the walls. This also applies to one-story buildings.

(c) ONE-STORY WALLS: The walls of a one-story building may be not less than 8 inches in thickness.

EXCEPTION: The walls of one-story single-family dwellings and private garages may be not less than 6 inches in thickness provided the masonry units meet the minimum requirements of Section 1402 for masonry units and mortar.

(d) WALLS OF RESIDENCE BUILDINGS: In residence buildings not more than three stories in height, walls other than coursed or rough or random rubble stone walls, may be of 8-inch thickness when not over 35 feet in height, provided the roof is designed to impart no horizontal thrust. Such walls in one-story buildings or private garages may conform to exception (c) above, and the provisions of Section 1405.1.

(e) PENTHOUSES AND ROOF STRUCTURES: Masonry walls above roof level, 12 feet or less in height, enclosing stairways, machinery rooms, shafts, or penthouses, may be of 8-inch thickness and may be considered as neither increasing the height nor requiring any increase in the thickness of the wall below.

(f) WALLS OF PLAIN CONCRETE: Plain concrete walls may be 2 inches less in thickness than required otherwise in this section but not less than 8 inches except that they may be 6 inches in thickness when meeting the provisions of exception (c) above.

(g) CAVITY WALLS: Cavity walls shall not exceed 35 feet in height. The cavity between wythes shall be not less than 2 inches (actual) nor more than 3 inches in width, and the minimum wythe thickness shall be

not less than 4 inches, except where 3-inch thick wythes are specifically permitted. The backing wythe shall be at least as thick as the facing wythe. (See Section 1401.)

(1) Where both the facing and backing wythes have a thickness of 4 inches, the height of such cavity walls shall not exceed 25 feet.

(2) Where both the facing and backing wythes are composed of solid masonry units, the wythes may be 3-inches thick but the height of such cavity walls shall not exceed 20 feet.

(h) MASONRY BONDED HOLLOW WALLS: Masonry bonded hollow walls shall not exceed 35 feet in height. The cavity between wythes shall not be less than 2 inches (actual) nor more than 4 inches in width, and the minimum wythe thickness shall not be less than 3 inches. The backing wythe shall be at least as thick as the facing wythe. (See Section 1401.)

(i) COMPOSITE OR FACED WALLS: Neither the height of faced (composite) walls nor the distance between lateral supports shall exceed that prescribed for the masonry of either of the types forming the facing or the backing.

(j) STONE WALLS: Rough or random or coursed rubble stone walls shall be 4 inches thicker than required for solid masonry walls of the same height, but in no case less than 16 inches in thickness.

1404.3—THICKNESS OF NON-BEARING WALLS

(a) EXTERIOR NON-BEARING WALLS: Non-bearing exterior masonry walls may be 4 inches less in thickness than required for bearing walls but the thickness shall be not less than 8 inches except where 6-inch walls are specifically permitted.

(b) EXTERIOR PANEL, APRON OR SPANDREL WALLS: Panel, apron or spandrel walls that do not exceed 13 feet in height above their support shall not be limited in thickness, provided they meet the fire-resistance requirements of Chapter XXV and are so anchored to the structural frame as to insure adequate lateral support and resistance to wind or other lateral forces (See Section 610).

1404.4—FOUNDATION WALLS

See Section 1302.5.

1404.5—INTERIOR BEARING PARTITIONS

The top three stories of Group A, B-1, C and D occupancies may be 8-inch in thickness provided the loads and stresses are not exceeded.

SECTION 1405—LATERAL SUPPORT

1405.1—EXTERIOR WALLS

Exterior masonry walls, whether they be bearing or non-bearing shall be supported either horizontally or vertically (whichever distance is the lesser) at right angles to the face of the wall at intervals not exceeding those shown in Table 5 except that an additional 6 feet will be permitted for gables in residential structures and private garages that do not exceed one story in height. (See Section 1403.7.) Where a structural analysis

indicates that the stresses in exterior walls containing openings exceed those permitted in Section 1403 the ratios in Table 5 should be reduced accordingly.

TABLE 5

LATERAL SUPPORT EXTERIOR WALLS

Wall Construction[1]	Design Wind Pressure psf[2]							
	15	20	25	30	35	40	45	50
	Maximum Ratio of Unsupported Height or length to thickness							
Grouted, Solid, Filled Cell Masonry or Plain Concrete Walls	22	22	20	18	17	16	15	14
Hollow Masonry or Masonry Bonded Hollow Walls	20	20	18	16	15	14	13	12
Cavity Walls[3]	18	18	16	15	14	13	12	11

[1]All masonry units to be laid in M, S, or N mortar. Where type N mortar is used and the wall spans in the vertical direction the ratios in Table 5 shall be reduced by 10 percent.

[2]For applicable design wind pressure see Section 1200.

[3]In computing the ratio for cavity walls the value for thickness shall be the sum of the nominal thickness of the inner and outer wythes.

1405.2—BEARING PARTITIONS

Masonry bearing partitions shall be supported either vertically or horizontally (whichever distance is the lesser) at right angles to the face of the wall at intervals not exceeding 24 times the wall thickness for solid masonry units, and 20 times the wall thickness for hollow masonry units when laid in Type M, S or N mortar. Gypsum partition tile or block shall not be used in bearing walls. (See Section 1403.7.)

1405.3—NON-BEARING PARTITIONS

(a) Non-bearing partitions shall be supported either vertically or horizontally (whichever distance is the lesser) at right angles to the face of the wall at intervals not exceeding 45 times the nominal wall thickness exclusive of plaster. (See Section 1403.7.)

(b) Gypsum partition tile shall not be used for partitions to receive portland cement plaster, ceramic tile, marble or structural glass, unless self-furring metal lath is placed over the gypsum tile. Gypsum partition tile or block shall not be used where they will be subjected to continuous dampness.

(c) Only gypsum cement mortar shall be used in the erection of gypsum partition tile or block.

1405.4—METHOD OF SUPPORT

(a) Lateral support shall be provided by intersecting walls, pilasters, columns, or other vertical members of sufficient strength to provide the required support when the distance is measured horizontally; or by floors, roofs, or other horizontal structural elements which are of sufficient strength to provide the required support when the distance is measured vertically.

(b) Sufficient bonding or anchorage shall be provided between the walls and its supports to resist the assumed wind or other horizontal forces acting either inward or outward. All structural elements relied upon for lateral support shall have sufficient strength and stability to transfer the horizontal force acting in either direction to adjacent structural members or to the ground. When floors or roofs are depended upon for receiving horizontal forces, provisions shall be made in the buildings to transfer the lateral forces to the ground.

1405.5—PILASTERS

When relied upon to provide the required lateral support, the width of pilasters shall be not less than one-tenth (1/10) the spaces between such pilasters. All pilasters shall be not less than four (4) inches thicker than the wall supported. In no case shall the distance between such pilasters exceed the lateral support provisions of Table 5. Pilasters designed by an architect or engineer to have sufficient strength and stability to transfer wind and other lateral loads to ground may be accepted by the Building Official.

1405.6—PIERS

The unsupported height of masonry piers shall not exceed 10 times their least dimension. When structural clay tile or hollow concrete masonry units are used for isolated piers to support beams and girders, the cellular spaces shall be filled solidly with concrete or Type M or S mortar. When hollow masonry units are solidly filled with concrete or Type M, S or N mortar, the allowable compressive stress may be increased as provided for in Table 4.

SECTION 1406—PARAPET WALLS

1406.1—GENERAL

(a) Parapet walls may be of plain solid masonry, hollow masonry units, cavity wall design or reinforced masonry as provided in this section.

(b) All parapet walls shall be properly coped with non-combustible, weatherproof material of a width not less than the thickness of the parapet wall.

(c) Proper flashings shall be installed in such a manner as to prevent moisture entering the wall through the joints in the coping.

(d) There shall be placed in all parapet walls scuppers or relief openings as close as practical to each downspout of not less than 4 to 6 inches in size and spaced not more than 6 inches above the roofline unless the roof is especially designed for water cooling, in which case the scuppers may be raised to provide for retaining the water.

1406.2—PLAIN MASONRY PARAPET WALLS

Parapet walls of plain solid masonry construction shall be not less than 8 inches in thickness and their height shall not exceed 4 times the nominal wall thickness. Parapet walls for fire walls and party walls shall be a minimum of 36 inches (Section 718).

1406.3—CAVITY WALL PARAPETS

Cavity wall parapets may be used when the facing and backing are constructed of solid masonry units and when they conform to all of the other requirements for cavity walls, except their height shall not exceed 4 times the combined nominal thickness of the facing and backing masonry units.

1406.4—REINFORCED MASONRY PARAPET WALLS

Unless reinforced to withstand safely wind loads to which they may be subjected, reinforced masonry parapet walls may be considered adequate if they conform to one of the following:

(a) When solid masonry parapet walls are reinforced both horizontally and vertically with not less than ¼-inch rods spaced not more than 2 feet on centers, the height shall be not more than 6 times the nominal wall thickness.

(b) When solid masonry parapet walls are reinforced both horizontally and vertically with a minimum of ¼-inch round rods horizontally on 16-inch centers and ⅜-inch round rods vertically on 24-inch centers, the height shall not exceed 8 times the nominal wall thickness.

SECTION 1407—BONDING

1407.1—GENERAL

The facing and backing of masonry walls and partitions shall be bonded in such a manner to provide for common action of the wythes of the material used. Bonding may be accomplished as outlined in Sections 1407.2, 1407.3, 1407.4, 1407.5, 1407.6, 1407.7, or 1407.8.

1407.2—BONDING WITH HEADERS

Where *solid masonry*, *faced* or *composite* wall construction is bonded by means of masonry headers, no less than 4 percent of the wall surface of each face shall be composed of headers extending not less than 3 inches into the backing. The distance between adjacent full-length headers shall not exceed 24 inches either vertically or horizontally. In walls in which a single header does not extend through the wall, headers from the opposite sides shall overlap at least 3 inches, or headers from opposite sides shall be covered with another header course overlapping the header below at least 3 inches.

1407.3—BONDING WITH METAL TIES

(a) Where *solid masonry*, *cavity*, *faced* or *composite* wall construction is bonded with metal ties the ties shall be corrosion resistant 3/16 inch diameter metal ties or wire of equivalent stiffness embedded in the horizontal mortar joints. There shall be one metal tie for not more than each 3 square feet of wall area. Ties in alternate courses shall be staggered, the maximum vertical distance between ties shall not exceed 24 inches, and

the maximum horizontal distance shall not exceed 36 inches. Rods or ties bent to rectangular shape shall be used with hollow masonry units laid with the cells vertical. In other walls the ends of ties shall be bent to 90 degree angles to provide hooks not less than 2 inches long. Additional bonding ties shall be provided at all openings spaced not more than 3 feet apart around the perimeter and within 12 inches of the opening. Walls bonded in accordance with this section shall conform to the allowable stress, lateral support, thickness (excluding cavity), height and mortar requirements for cavity walls unless the collar joint in such walls are filled with mortar.

(b) *Cavity walls* shall be bonded in accordance with the requirements of Section 1407.3(a).

1407.4—BONDING WITH HOLLOW MASONRY UNITS

Where two or more hollow units are used to make up the thickness of a wall, the stretcher courses shall be bonded at vertical intervals not exceeding 3 feet, by lapping at least 4 inches over the unit below or by lapping with units at least 50 percent greater in thickness than the unit below at vertical intervals not exceeding 17 inches, or bonded with corrosion-resistant metal ties conforming to the requirements of Section 1407.3(a).

1407.5—ASHLAR, NATURAL OR CAST STONE

(a) CONSTRUCTION: In ashlar masonry, bond stones uniformly distributed shall be provided to the extent of not less than 10 percent of the area of exposed faces.

Rubble stone masonry 24 inches or less in thickness shall have bond stones with a maximum spacing of 3 feet vertically and 3 feet horizontally and, if the masonry is of greater thickness than 24 inches, shall have one bond stone for each 6 square feet of wall surface on both sides.

(b) MINIMUM THICKNESS: Stone masonry walls shall in no case have a minimum thickness of less than 16 inches.

1407.6—MASONRY BONDED HOLLOW WALLS

(a) In masonry bonded hollow walls, the facing and backing shall be bonded so that not less than 4 percent of the wall surface of each face is composed of masonry bonding units extending not less than 3 inches into the backing. The distance between adjacent bonders shall not exceed 24 inches either vertically or horizontally.

(b) Where the bonding units have a compressive strength of 4500 psi gross area, the facing and backing may be bonded so that not less than 2 percent of the wall area is composed of bonders.

1407.7—STACK BOND OF MASONRY WALLS

Where masonry units are laid in stack bond, continuous prefabricated joint reinforcement or other steel bar or wire reinforcement shall be embedded in the horizontal mortar beds at vertical intervals not to exceed 16 inches. The longitudinal bar or wire of such reinforcement shall be corrosion resistant and not less than No. 9 gage and at least one longitudinal bar or wire shall be provided for each 6 inches of wall thickness or fraction thereof.

1407.8—BONDING WITH PREFABRICATED JOINT REINFORCEMENT

Where prefabricated joint reinforcement is used for the bonding of the facing and backing of stack bond, cavity, faced or composite, or other multi-wythe constructed masonry walls, there shall be one cross wire serving as a tie for not more than each 2 feet of wall area. The vertical spacing of the reinforcement shall not exceed 16 inches. Cross wires on prefabricated joint reinforcement shall be corrosion resistant and shall be not less than No. 9 gage.

SECTION 1408—ANCHORAGE

1408.1—GENERAL

All structural elements depending upon one another for continuity or support shall be securely anchored in such a manner as to resist all forces which might tend to separate the structural elements. It is particularly important that adequate anchorage be provided between the roof structure and load-bearing masonry walls to prevent the uplifting and subsequent separation of the roof from the masonry wall as the result of wind pressures.

1408.2—ROOF ANCHORAGE

Roof structures shall be securely anchored to load-bearing masonry walls. Anchorage shall be provided to resist the wind forces set forth in Section 1200. Minimum anchorage shall be provided in one of the following manners or its equivalent.

(a) Anchorage may be provided by ½-inch bolts extending a minimum of 15 inches into the masonry and spaced not more than 6 feet on centers. A steel plate having a minimum surface area of 6 square inches shall be securely attached to the head of the bolt and completely embedded in the masonry.

(b) Where a continuous bond beam at least 8 inches deep and having a minimum continuous reinforcing of 0.2 square inches is provided at the top of the wall, anchorage may be provided by one of the following methods:

(1) Welding ½-inch anchor bolts to longitudinal reinforcing.

(2) Hooking tightly around the longitudinal reinforcing through 180°.

With this type of anchorage, bolt need only extend into the wall a minimum of 6 inches.

(c) See Section 1205.3 for anchorage of roofs in areas of high winds.

1408.3—FLOOR ANCHORAGE

(a) Wood floor joists or beams bearing on masonry walls shall be securely anchored to the walls at intervals not exceeding 6 feet by metal anchors having a minimum cross-section of 0.25 square inches and at least 16 inches long, securely fastened to the joists or beams at one end of the anchor by means of a single bolt or other approved method, and the other end of the anchor securely built not less than 3½ inches into the masonry. Where joists run parallel to walls, such anchors shall engage not less than 3 joists, and the joists shall be solidly bridged at the anchor.

(b) Steel floor joists not supporting a concrete slab floor shall be anchored in a manner providing anchorage equivalent to that required for wood floor joists. Concrete slabs bearing on masonry walls shall be considered to provide adequate anchorage without additional anchorage.

1408.4—ANCHORING INTERSECTING WALLS AND PARTITIONS

Masonry walls that meet or intersect shall be adequately bonded or anchored as follows:

(a) Intersecting bearing walls may be bonded either by laying a true bond of at least 50 percent of the units at the intersection or by using corrosion-resistant metal ties embedded in the bed joints. When metal ties are used for such bonding, they shall be corrosion-resistant 3/16-inch diameter steel rods bent to a rectangular shape and spaced at intervals not exceeding 16 inches vertically. They shall be placed in such a manner as to extend at least 3 inches into each intersecting wall.

(b) Non-bearing partitions, when intersecting walls or partitions, shall be anchored with metal ties or clips at least ⅞ inch wide and not less than 16 gage galvanized iron at intervals of not less than 32 inches vertically.

(c) Brick or tile facing against concrete shall be anchored to the concrete by the use of dovetailed anchors inserted in slots built into the concrete. Anchors shall be at least ⅞ inch wide and not less than 16 gage galvanized iron. They shall be spaced not more than 18 inches vertically and 24 inches horizontally.

(d) Two-inch split furring and 2-inch open back (split) tile (soaps) shall be anchored to the backing with hardware cloth ties consisting of ½ inch mesh, No. 20 gage galvanized iron fabric, at least 4 inches wide and extending at least 3 inches into the masonry and to within ½ inch of the face of the furring, or by other approved ties. Ties shall be spaced not farther apart than 24 inches vertically and 36 inches horizontally.

SECTION 1409—MISCELLANEOUS DETAILS

1409.1—CHANGE IN WALL THICKNESS

Except for permissable chases and recesses, walls shall not vary in thickness between their lateral supports. Where cavity walls or walls of hollow masonry units are decreased in thickness, a course of solid masonry not less than 4 inches in thickness shall be interposed between the wall below and the thinner wall above, or the hollow units in the top course of the thicker wall shall be filled solidly with concrete or Type M, S, or N mortar.

1409.2—CHASES

(a) Chases in masonry walls shall not be deeper than ⅓ the wall thickness, nor longer than 4 feet horizontally, except that chases below windows may equal the width of the opening above.

(b) No chase shall be cut or built in an 8-inch wall or within the required area of a pier, except that in buildings of residential occupancy not more than 2 stories in height, chases not more than 4 inches deep may be built in 8 inch walls.

(c) Chases shall not be cut in cavity walls, hollow walls or walls of hollow units but, when permitted, may be built in.

1409.3—SUPPORTED STRUCTURAL MEMBERS

(a) When combustible structural members frame into walls of thicknesses not greater than 12 inches, they shall project not more than 4 inches into the wall and shall be so spaced that the distance between embedded ends is not less than 4 inches. The space above, below, and between such members shall be filled solidly with burnt-clay materials, mortar, concrete, or equivalent fire-resistive material to a depth of not less than 4 inches on all sides of the members.

(b) Beams, joists, girders or other concentrated loads supported by a wall or pier shall have bearing at least 4 inches in length upon solid masonry or upon a bearing plate of adequate design and dimensions to distribute safely the loads on the wall or pier and in no case shall the stresses be greater than allowed in Section 1403.

1409.4—SUPPORT ON WOOD

No masonry shall be supported on combustible construction, except that prefabricated partitions, weighing not more than 30 pounds per square foot, properly strapped or reinforced and provided with proper nailing devices for attachment may be supported on combustible construction, provided the supporting construction has been designed to carry such loads.

1409.5—CORBELLING

The maximum horizontal projection of corbelling from the face of the wall from which it projects shall not exceed ½ of the nominal wall thickness. Individual corbells or the maximum projection of one unit shall not exceed ½ the height of the unit nor ⅓ its bed depth. For corbelling of chimneys see Section 802.1(b).

1409.6—ARCHES AND LINTELS

The masonry above openings shall be supported by well buttressed arches or lintels of metal or masonry, plain or reinforced, which shall bear on the wall at each end for not less than 4 inches. In addition, the bearing area shall be sufficient to prevent a concentration of compressive stresses greater than those allowed in Table 4, Section 1403.

1409.7—PROTECTION AGAINST FREEZING

All masonry shall be protected against freezing for at least 24 hours after laying. No masonry shall be built upon frozen material.

1409.8—WETTING OF MASONRY UNITS

(a) Brick of clay or shale shall be wetted when laid unless their gain in weight is less than 0.025 ounce per square inch of surface when immersed flatwise in ⅛ inch of water for one minute.

(b) Structural clay tile having absorptions (1-hour boil) of 12 percent or more shall be wetted before laying.

1409.9—CONSTRUCTION PRECAUTIONS

Except when carried independently by girders at each floor, no wall shall be built up more than 25 feet in height in advance of other walls of the building. Walls shall be adequately braced during erection. Masonry walls in locations where they may be exposed to high winds during

erection shall not be built higher than 10 times their thickness unless adequately braced or until provision is made for the prompt installation of permanent bracing at the floor or roof level immediately above the story under construction. Back fill shall not be placed against foundation walls until they have been braced to withstand the horizontal pressure.

1409.10—USE OF EXISTING WALLS

(a) An existing masonry wall may be used in the alteration or extension of a building, provided that under the new conditions it meets the requirements of this Code and is structurally sound or can be made so by reasonable repairs.

(b) No existing wall shall be used for the alteration or extension of a building, or increased in height without specific written permission from the Building Official.

SECTION 1410—PLAIN GROUTED MASONRY

1410.1—GENERAL

(a) Grouted masonry shall conform to all requirements of Section 1401 to 1409 inclusive, except as modified by this Section.

(b) Plain grouted masonry is that form of construction made with clay, shale or concrete masonry units in which the interior joints are filled by pouring grout therein as the work progresses.

(c) The masonry units in either the facing or backing, but not necessarily both, at the time of laying, shall absorb in 24 hours of cold immersion an amount of water weighing at least 5 percent of the dry weight of the unit.

1410.2—MORTAR AND GROUT

(a) Only Types M, S or N mortar shall be used. Grout shall be Types M, S or N mortars with the addition of sufficient water to give the required pouring consistency without segregation of the constituents of the mortar.

(b) In grout spaces of 2 inches or more in both horizontal dimensions, the grout may contain an addition of pea gravel equal to not more than 2 parts by volume of the cement. Such pea gravel shall be graded with not more than 5 percent passing the No. 8 sieve and with not less than 95 percent passing the ⅜-inch sieve.

(c) Brick pieces or chips may be embedded into grout in such spaces, provided each piece or chip is surrounded by not less than ½ inch of grout.

(d) Where the minimum continuous clear openings of a grout space exceeds 6 inches, it may be filled and treated as unreinforced monolithic concrete.

1410.3—BOND

Where all interior joints are filled with grout, masonry headers shall not be used, but metal wall ties may be used to prevent spreading of the wythes and to maintain the vertical alignment of the wall.

1410.4—CONSTRUCTION REQUIREMENTS

All masonry units in the 2 outer tiers or wythes shall be laid plumb with full bed and head joints. All interior joints shall be filled with grout. One of

the outer tiers may be carried up not more than 8 inches before grouting, but the other face tier shall be carried up not more than 5½ inches above the grout. Each pour of grout shall be stopped at least 1½ inches below the top and properly puddled. The longitudinal vertical joints (collar joints) shall be not less than ¾ inch in width.

SECTION 1411—REINFORCED MASONRY

1411.1—GENERAL REQUIREMENTS

(a) Reinforced *concrete masonry* shall conform to the provisions of "Building Code Requirements for Reinforced Masonry" of the American Standards Association A41.2—1960. (Handbook 74).

(b) Reinforced *Clay Masonry* shall conform to the provisions of "Recommended Building Code Requirements for Engineered Brick Masonry"—SCPI May, 1966.

(c) The Building Official may require a copy of the *structural analysis* (by an Architect or Engineer) for his file. He may require the designer or other qualified person to supervise the work.

SECTION 1412—REINFORCED GYPSUM CONCRETE

1412.1—GENERAL

(a) Reinforced Poured Gypsum Concrete shall conform to the requirements of ASTM Standard Specifications for Gypsum Concrete, C317-64.

(b) The design and application of reinforced gypsum concrete shall be in accordance with the requirements of ASA Standard A59.1 dated December 29, 1954, American Standards Association Specifications for Reinforced Gypsum Concrete.

(c) A competent inspector, satisfactory to the Building Official, shall be present on the work at all times when cast-in-place gypsum concrete is being mixed or deposited.

SECTION 1413—STRUCTURAL GLASS BLOCK

1413.1—WHERE PERMITTED

Masonry of glass blocks may be used in non-load-bearing exterior or interior walls and in openings which might otherwise be filled with windows, either isolated or in continuous bands, provided the glass block panels have a thickness of not less than 3½ inches at the mortar joint and the mortared surfaces of the blocks are satisfactorily treated for mortar bonding.

1413.2—SIZE OF PANELS

Glass block panels for exterior walls shall not exceed 144 square feet of unsupported wall surface nor 25 feet in length nor 20 feet in height between supports. For interior walls, glass block panels shall not exceed 250 square feet of unsupported area nor 25 feet in one direction between supports.

1413.3—REINFORCEMENT OF EXTERIOR PANELS

(a) ANCHORAGE: Exterior glass block panels shall be held in place in the wall opening to resist both external and internal pressures due to

wind. Panels shall be set in recesses at the jambs and, for panels exceeding 10 feet in horizontal dimension between supports, at the head as well, so as to provide a bearing surface at least one inch wide along the panel edges; except that when approved by the Building Official for panels exceeding neither 100 square feet in area nor 10 feet in either horizontal or vertical dimension, and situated 4 stories or less, anchorage may be provided by means of non-corrodible perforated metal strips.

(b) PLACING REINFORCEMENT: Glass block panels shall have reinforcement in the horizontal mortar joints, extending from end to end of mortar joints, but not across expansion joints, with any unavoidable joints spliced by lapping the reinforcement not less than 6 inches. The reinforcement shall be spaced not more than 2 feet apart vertically. In addition reinforcements shall be placed in the joint immediately below and above any openings within a panel. The reinforcement shall consist of 2 parallel, longitudinal, galvanized steel wires, No. 9 gage or larger, spaced 2 inches apart, and having welded thereto No. 14 or heavier gage cross wires at intervals not exceeding 8 inches, or the equivalent approved by the Building Official.

1413.4—MORTAR

Glass block shall be laid in Type M, S or N mortar. Both vertical and horizontal mortar joints shall be at least ¼ inch and not more than ⅝ inch thick and shall be completely filled.

1413.5—EXPANSION JOINTS

Every exterior glass block panel shall be provided with expansion joints at the sides and top. Expansion joints shall be entirely free of mortar, and shall be filled with resilient material.

SECTION 1414—VENEERED WALLS

1414.1—GENERAL

(a) Veneer as used in this section refers to a facing of brick, tile, concrete, masonry units, metal, including metal coated with porcelain enamel, glass or similar material securely attached to a wall for the purpose of providing ornamentation, protection, or insulation but not so bonded as to exert a common reaction under load.

(b) Veneer shall not be assumed as supporting any load other than its own weight, neither shall it be assumed to add to the strength of the wall.

(c) Exterior veneer shall not be attached to wood at any point more than 20 feet above the adjacent ground elevation.

1414.2—VENEER OF STRUCTURAL MASONRY UNITS

Veneer of structural masonry units shall apply to all veneer composed of units meeting the physical requirements of this Chapter, set in mortar and not less than 1⅝ inches in actual thickness for solid masonry units, and not less than 3 inches in actual thickness for hollow masonry units.

1414.3—SUPPORT OF VENEER OF MASONRY UNITS

The weight of all masonry veneer 1⅝ inches or greater in actual thickness shall be supported upon footings, foundation walls or other approved non-combustible structural supports.

1414.4—ANCHORAGE OF VENEER OF MASONRY UNITS

(a) All masonry veneer 1⅝ inches or greater in actual thickness shall be attached to the supporting wall either by headers as provided in Section 1407.2, or with corrosion-resistant metal ties or other approved methods.

(b) Veneer ties, if of strand wire, shall be not less than No. 6 W. & M. gage wire with the end of the wire bent to a 90-degree angle to form a hook not less than 2 inches long embedded in the mortar joint. Veneer ties, if of corrugated sheet metal, shall be not less than 22 U. S. gage. Each metal tie shall support not more than 3 square feet of wall area and shall not be spaced farther apart than 16 inches vertically and 32 inches horizontally.

1414.5—HEIGHT OF VENEER OF MASONRY UNITS

Masonry veneer 1⅝ inches or greater in thickness shall not be attached to wood framing at any point more than 20 feet above the foundation, except in gables. Such veneer attached to masonry walls shall not exceed 35 feet in height above approved supports.

1414.6—VENEER OF NON-STRUCTURAL UNITS

Veneer of non-structural units shall apply to all veneer less than 1⅝ inches in thickness and the units shall not be assumed to support any superimposed loads.

1414.7—ANCHORAGE GENERAL

Non-structural materials used as veneer shall be anchored to the supporting wall by corrosion-resistant metal ties not less in thickness than No. 9 W. & M. gage wire, and spaced not more than 12 inches apart both horizontally and vertically or by other approved devices or methods. Such attachments and their supports shall be capable of resisting a horizontal force equal to the wind loads specified in this Code, but in no case less than 20 pounds per square foot.

1414.8—ADHESION TYPE ANCHORAGE

(a) MATERIAL: Approved units or units less than 1⅝ inches in thickness of flat tile, stone or adhesion type architectural terra cotta manufactured with keyed or scored back surface may be cemented to a masonry or concrete wall or to exterior portland cement mortar on high rib metal lath with a Type M or S mortar provided the mortar bond is sufficient to withstand a shearing stress of 50 pounds per square inch after curing for 28 days. No individual unit so attached shall exceed 30 inches in any one dimension and shall not have more than 540 square inches of superficial face area.

(b) INSTALLATION: Just before setting, each piece shall be soaked in clean water for one hour or more and the surface of the backing wall shall be saturated with water applied through a hose nozzle at a pressure of at least 25 pounds per square inch. A brush coat of neat portland cement and water shall then be applied both to the backing and the back side of the veneer. The mortar shall average ¾ inch in thickness. One-half of the mortar (⅜ inch) shall be applied to the veneer unit and half to backing just prior to setting. Pieces disturbed after having been tapped into place shall be removed immediately, after which additional mortar shall be applied as required above and the piece reset.

1414.9—METAL VENEER—REQUIREMENTS

(a) MATERIAL: Metal veneers that are exposed to the weather shall be of corrosion-resistant metal, or metal covered front and back with porcelain enamel or given other approved treatment or coating to render them corrosion-resistant.

(b) ATTACHMENT: Exterior metal veneer shall be securely attached to the supporting masonry or framing members with corrosion-resistant fastenings, metal ties or by other approved devices or methods. The spacing of the fastenings or ties shall not exceed 24 inches either vertically or horizontally, except where wider spacing is deemed adequate and specifically approved by the Building Official; but where units exceed 4 square feet in area there shall be not less than four attachments per unit. The metal attachments shall have a cross-sectional area not less than provided by No. 9 W. & M. gage wire (0.0173 square inch). Such attachments and their supports shall be capable of resisting a horizontal force equal to the wind loads specified in this Code, but in no case less than 20 pounds per square foot.

(c) SUPPORTS: Metal supports for exterior metal veneer shall be protected by painting, galvanizing, or by other approved equivalent coating or treatment. Wood studs, furring strips, or other wood supports for exterior metal veneer shall be pressure-treated with an approved preservative or otherwise protected against decay in an approved manner.

(d) PROTECTION: All joints and edges in metal veneer that are exposed to the weather shall be caulked or painted with approved durable waterproofing material, or shall be protected by other approved means to prevent penetration of moisture.

No masonry backup shall be required for metal veneer except as is necessary to meet the fire-resistance requirements of this Code.

(e) GROUNDING METAL VENEERS: Metal veneers fastened to supporting elements which are not a part of the grounded metal framing of a building shall be made electrically continuous by contact or interconnection of individual units and shall be effectively grounded. The conductor used to ground the veneer shall have no greater resistance than the conductor used to ground the electrical system within the building. Where a metal veneer is applied to a building with no electrical wiring system, grounding shall be required only if determined to be necessary by the Building Official.

1414.10—GLASS VENEER—REQUIREMENTS

(a) AREA: The area of a single section of thin exterior structural glass veneer shall not exceed 10 square feet where not more than 15 feet above the level of the sidewalk or grade level directly below, and shall not exceed 6 square feet where more than 15 feet above that level.

(b) LENGTH OR HEIGHT: The length or height of any section of thin exterior structural glass veneer shall not exceed 48 inches.

(c) THICKNESS: The thickness of thin exterior structural glass veneer shall be not less than 11/32 inch.

1414.11—ATTACHMENT

Thin exterior structural glass veneer shall be set only after backing is thoroughly dry and after application of an approved bond coat applied

uniformly over the entire surface of the backing so as to effectively seal the surface. Glass shall be set in place with an approved mastic cement in sufficient quantity so that at least 50 percent of the area of each glass unit is directly bonded to the backing by mastic not less than ¼ inch thick and not more than ⅝ inch thick. Bond coat and mastic shall preferably be from the same manufacturer and shall bond firmly together.

1414.12—GLASS AT SIDEWALK LINE

Where glass extends to sidewalk surface, each section shall rest in an approved metal moulding, and set at least ¼ inch above the highest point of the sidewalk. The space between the moulding and the sidewalk shall be thoroughly caulked and made watertight.

1414.13—JOINTS

(a) ABUTTING EDGES: Unless otherwise specifically approved by the Building Official, all abutting edges of thin exterior structural glass veneer shall be ground square. Mitered joints shall not be used except when specifically approved for wide angles.

(b) TREATMENT OF JOINTS: All joints shall be uniformly buttered with an approved jointing compound and all horizontal joints shall be held to not less than 1/16 inch by an approved non-rigid substance or device.

(c) EXPANSION JOINTS: Where thin exterior structural glass veneer abuts non-resilient material at sides or top, expansion joints not less than ¼ inch wide shall be provided.

1414.14—SHELF ANGLES

When thin exterior structural glass veneer is installed above the level of the top of a bulkhead facing, or at a level more than 36 inches above the sidewalk level, the mastic cement binding shall be supplemented with approved non-ferrous metal shelf angles located in the horizontal joints in every course. Such shelf angles shall be of not less than 18 U.S. gage and not less than 2 inches in length, and shall be spaced at approved intervals, with not less than 2 angles for each glass unit. Shelf angles shall be secured to the wall or backing with expansion bolts, toggle bolts, or by other approved methods.

1414.15—MECHANICAL FASTENINGS

(a) WHERE REQUIRED: All thin exterior structural glass veneer installed above the level of the heads of show windows and all such veneer installed more than 12 feet above sidewalk level, shall, in addition to the mastic cement and shelf angles, be held in place by the use of approved fastenings at each vertical or horizontal edge, or at the 4 corners of each glass unit.

(b) ATTACHMENT TO BACKING: Fastenings shall be secured to the wall or backing with expansion bolts, toggle bolts, or by other approved method.

(c) TYPE AND DESIGN: Fastenings shall be of approved type and be so designed as to hold the glass veneer in a vertical plane independently of the mastic cement. Shelf angles providing both support and fastenings may be used.

1414.16—FLASHING

Exposed edges of thin exterior structural glass veneer shall be flashed with over-lapping corrosion-resistant metal flashing and caulked with a waterproof compound in an approved manner to effectively prevent the entrance of moisture between the glass veneer and the backing.

CHAPTER XV—STEEL CONSTRUCTION

SECTION 1501—GENERAL

The quality, design, fabrication and erection of steel and iron used structurally in buildings or structures shall conform to the provisions of Section 1502 through 1505 of this chapter.

SECTION 1502—STRUCTURAL STEEL CONSTRUCTION

The design, fabrication and erection of structural steel for buildings shall conform to the requirements of the Specification for the Design, Fabrication and Erection of Structural Steel for Buildings of the American Institute of Steel Construction adopted April 17, 1963.

SECTION 1503—LIGHT GAGE COLD-FORMED STEEL CONSTRUCTION

The design of light gage cold-formed steel construction shall conform to the Specification for the Design of Light Gage Cold-Formed Steel Structural Members of the American Iron and Steel Institute, 1962 Edition.

All individual structural members and assembled panels of light gage cold-formed steel construction, except where fabricated of approved corrosion-resistive steel or of steel having a corrosion-resistive metallic or other approved coating, shall be protected against corrosion with an acceptable shop coat of paint, enamel, or other approved protection.

SECTION 1504—OPEN WEB STEEL JOIST CONSTRUCTION

The design, fabrication and erection of open web steel joist construction shall comply with the following specifications:

"Standard Specifications for Open Web Steel Joists, J- and H- Series, adopted by American Institute of Steel Construction and Steel Joist Institute, effective March 1, 1965."

"Standard Specifications for Longspan Steel Joists, LJ- and LH- Series, adopted by American Institute of Steel Construction and Steel Joist Institute, effective July 1, 1966."

SECTION 1505—WELDING

Details of design, workmanship and technique for welding, inspection of welding and qualification of welding operators shall conform to the recommendations of the Code for Welding in Building Construction, AWS D1.0-66, adopted by the American Welding Society, 1966.

CHAPTER XVI—CONCRETE CONSTRUCTION

SECTION 1601—GENERAL

All structures of reinforced concrete, including prestressed concrete, shall be designed and constructed in accordance with the provisions of "Building Code Requirements for Reinforced Concrete (ACI 318-63)" of the American Concrete Institute.

SECTION 1602—METHODS OF DETERMINING THE PROPORTIONS OF CONCRETE

(a) The determination of the proportions of cement, aggregate and water to attain the required strengths shall be made by one of the following methods, except:

(1) Concrete that is to be subject to freezing temperatures while wet shall have a water cement ratio not exceeding 6 gal. per bag and it shall contain entrained air.

(2) Concrete that will be exposed to sulfate-containing or other chemically aggressive solutions shall be proportioned in accordance with "Recommended Practice for Selecting Proportions for Concrete (ACI 613)" and "Recommended Practice for Selecting Proportions for Structural Lightweight Concrete (ACI 613)."

Method 1—Without preliminary tests.

(b) When preliminary test data on the materials to be used in the concrete have not been obtained, the water-cement ratio for a given strength of concrete shall not exceed the values shown in Table 1602.1 and the cement factor for a given strength shall be not less than shown in Table 1602.1. When strengths in excess of 4000 psi are required or when lightweight aggregate or admixtures (other than those exclusively for the purpose of entraining air) are used, the required water-cement ratio shall be determined by Method 2.

Method 2—For combinations of materials previously evaluated or to be established by trial mixtures.

(a) Water-cement ratios or strengths greater than shown in Table 1602.1 may be used provided that the relationship between strength and water-cement ratio for the materials to be used has been previously established by reliable test data and the resulting concrete satisfies the requirements of Section 1604.

(b) Where previous data are not available, concrete trial mixtures having proportions and consistency suitable for the work shall be made using at least three different water-cement ratios (or cement content in the case of lightweight aggregates) which will produce a range of strengths encompassing those required for the work. These tests shall be made in accordance with the procedure given in the appendix to "Recommended Practice for Selecting Proportions for Concrete" (ACI 613) or "Recommended Practice for Selecting Proportions for Structural Lightweight Concrete" (ACI 613A). For each water-cement ratio (or cement content), at least three specimens for each age to be tested shall be made and cured in accordance with "Method of Making and Curing Concrete Compression

TABLE 1602.1

MAXIMUM PERMISSIBLE WATER-CEMENT RATIOS AND MINIMUM CEMENT FACTORS FOR CONCRETE

Specified compressive strength at 28 days f'c	Minimum sks. cement per c. y. concrete	Maximum permissible water-cement ratio*	
		U.S. gal. per 94# bag of cement non-air-entertained concrete	U.S. gal. per 94# bag of cement air-entrained concrete
2500	5	7¼	6¼
3000	5½	6½	5¼
3500	6	5¾	4½
4000	6½	5	4

*Including free surface moisture on aggregates.

and Flexure Test Specimens in the Laboratory" (ASTM C192) and tested for strength in accordance with "Method of Test for Compressive Strength of Molded Concrete Cylinders" (ASTM C39).

(c) The strength tests shall be made at 28 days or the earlier age at which the concrete is to receive load, as indicated on the plans. A curve shall be established showing the relationship between water-cement ratio (or cement content) and compressive strength. The maximum permissible water-cement ratio for the concrete to be used in the structure shall be that shown by the curve to produce an average strength to satisfy the requirements of Section 1604 provided that the water-cement ratio shall be no greater than that required by Section 1602(a).

(d) Where different materials are to be used for different portions of the work, each combination shall be evaluated separately.

SECTION 1603—CONCRETE PROPORTIONS AND CONSISTENCY

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

(b) The methods of measuring concrete materials shall be such that the proportion can be accurately controlled and easily checked at any time during the work.

SECTION 1604—STRENGTH TESTS OF CONCRETE

(a) When strength is a basis for acceptance, each class of concrete shall be represented by at least five tests (10 specimens). Two specimens shall

be made for each test at a given age, and not less than one test shall be made for each 150 cu. yd. of structural concrete, but there shall be at least one test for each day's concreting. The Building Official may require a reasonable number of additional tests during the progress of the work. Samples from which compression test specimens are molded shall be secured in accordance with "Method of Sampling Fresh Concrete" (ASTM C172). Specimens made to check the adequacy of the proportions for strength of concrete or as a basis for acceptance of concrete shall be made and laboratory-cured in accordance with "Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field" (ASTM C31). Additional test specimens cured entirely under field conditions may be required by the Building Official to check the adequacy of curing and protection of the concrete. Strength tests shall be made in accordance with "Method of Test for Compressive Strength of Molded Concrete Cylinders" (ASTM C39).

(b) The age for strength tests shall be 28 days or, where specified, the earlier age at which the concrete is to receive its full load or maximum stress. Additional tests may be made at earlier ages to obtain advance information on the adequacy of strength development where age-strength relationships have been established for the materials and proportions used.

(c) To conform to the requirements of this code.

(1) For structures designed by working stress design, the average of any five consecutive strength tests of the laboratory-cured specimens representing each class of concrete shall be equal to or greater than the specified strength, f'c, and not more than 20 percent of the strength tests shall have values less than the specified strength.

(2) For structures designed by ultimate strength design, and for prestressed structures the average of any three consecutive strength tests of the laboratory-cured specimens representing each class of concrete shall be equal to or greater than the specified strength, f'c, and not more than 10 percent of the strength shall have values less than the specified strength.

(d) When it appears that the laboratory-cured specimens will fail to conform to the requirements for strength, the Building Official shall have the right to order changes in the concrete sufficient to increase the strength to meet these requirements. The strengths of any specimens cured on the job are intended to indicate the adequacy of protection and curing of the concrete and may be used to determine when the forms may be stripped, shoring removed, or the structure placed in service. When, in the opinion of the Building Official, the strengths of the job-cured specimens are excessively below those of the laboratory-cured specimens, the contractor may be required to improve the procedures for protecting and curing the concrete.

(e) In addition, when concrete fails to conform to the requirements of (c) or when tests of field-cured cylinders indicate deficiencies in protection and curing, the Building Official may require tests in accordance with "Methods of Securing, Preparing and Testing specimens from Hardened Concrete for Compressive and Flexural Strength" (ASTM C42) or order load tests as outlined in ACI 318-63, Chapter 2, for that portion of the structure where the questionable concrete has been placed.

SECTION 1605—WALLS

1605.1

Except as permitted by ACI Code (ACI 318-63) reinforced concrete walls shall conform to the limitations of this section.

(a) Reinforced concrete bearing walls shall have a thickness of at least 1/25 of the unsupported height or width, whichever is the shorter.

(b) Reinforced concrete bearing walls of buildings shall be not less than 6 inches thick for the uppermost 15 feet of their height; and for each successive 25 feet downward, or fraction thereof, the minimum thickness shall be increased 1 inch. Reinforced concrete bearing walls of two story dwellings may be 6 inches thick throughout their height.

(c) The area of the horizontal reinforcement of reinforced concrete walls shall be not less than 0.0025 and that of the vertical reinforcement not less than 0.0015 times the area of the reinforced section of the walls if of bars, and not less than three-fourths as much if of welded wire fabric. The wire of the welded fabric shall be of not less than No. 10 AS & W gage.

(d) Walls more than 10 inches thick, except for basement walls, shall have reinforcement for each direction placed in two layers parallel with the faces of the wall. One layer consisting of not less than one-half and not more than two-thirds the total required shall be placed not less than 2 inches nor more than one-third the thickness of the wall from the exterior surface. The other layer, comprising the balance of the required reinforcement, shall be placed not less than three-quarters inches and not more than one-third the thickness of the wall from the interior surface. Bars, if used, shall not be less than #3 bars, nor shall they be spaced more than 18 inches on centers. Welded wire reinforcement for walls shall be in flat sheet form.

(e) In addition to the minimum prescribed in (c) there shall be not less than two #5 bars around all window or door openings. Such bars shall extend at least 24 inches beyond the corner of the openings.

(f) Reinforced concrete walls shall be anchored to the floors, or to the columns, pilasters, buttresses, and intersecting walls with reinforcement at least equivalent to #3 bars 12 inches on centers, for each layer of wall reinforcement.

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

(h) Exterior basement walls and foundation walls shall not be less than 8 inches.

SECTION 1606—FOOTINGS

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

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

SECTION 1607—VERMICULITE CONCRETE

Vermiculite concrete when used in roof systems and slabs-on-grade, shall comply with the "American Standard Specifications for Vermiculite Concrete Roofs and Slabs-on-Grade (ASA-A122.1—1965)."