CHAPTER 19
CONCRETE

Italics are used for text within Sections 1903 through 1908 of this code to indicate provisions that differ from ACI 318.

SECTION 1901
GENERAL

1901.1 Scope. The provisions of this chapter shall govern the materials, quality control, design and construction of concrete used in structures.

1901.2 Plain and reinforced concrete. Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318 as amended in Section 1908 of this code. Except for the provisions of Sections 1904 and 1910, the design and construction of slabs on grade shall not be governed by this chapter unless they transmit vertical loads or lateral forces from other parts of the structure to the soil.

1901.3 Source and applicability. The format and subject matter of Sections 1902 through 1907 of this chapter are patterned after, and in general conformity with, the provisions for structural concrete in ACI 318.

1901.4 Construction documents. The construction documents for structural concrete construction shall include:

1. The specified compressive strength of concrete at the stated ages or stages of construction for which each concrete element is designed.
2. The specified strength or grade of reinforcement.
3. The size and location of structural elements, reinforcement, and anchors.
4. Provision for dimensional changes resulting from creep, shrinkage and temperature.
5. The magnitude and location of prestressing forces.
6. Anchorage length of reinforcement and location and length of lap splices.
7. Type and location of mechanical and welded splices of reinforcement.
8. Details and location of contraction or isolation joints specified for plain concrete.
9. Minimum concrete compressive strength at time of posttensioning.
10. Stressing sequence for posttensioning tendons.
11. For structures assigned to Seismic Design Category D, E or F, a statement if slab on grade is designed as a structural diaphragm (see Section 21.10.3.4 of ACI 318).

1901.5 Special inspection. The special inspection of concrete elements of buildings and structures and concreting operations shall be as required by Chapter 17.

SECTION 1902
DEFINITIONS

1902.1 General. The words and terms defined in ACI 318 shall, for the purposes of this chapter and as used elsewhere in this code for concrete construction, have the meanings shown in ACI 318.

SECTION 1903
SPECIFICATIONS FOR TESTS AND MATERIALS

1903.1 General. Materials used to produce concrete, concrete itself and testing thereof shall comply with the applicable standards listed in ACI 318. *Where required, special inspections and tests shall be in accordance with Chapter 17.*

1903.2 Glass fiber reinforced concrete. *Glass fiber reinforced concrete (GFRC) and the materials used in such concrete shall be in accordance with the PCI MNL 128 standard.*

SECTION 1904
DURABILITY REQUIREMENTS

1904.1 Water-cementitious materials ratio. Where maximum water-cementitious materials ratios are specified in ACI 318, they shall be calculated in accordance with ACI 318, Section 4.1.

1904.2 Freezing and thawing exposures. Concrete that will be exposed to freezing and thawing, deicing chemicals or other exposure conditions as defined below shall comply with Sections 1904.2.1 through 1904.2.3.

1904.2.1 Air entrainment. Concrete exposed to freezing and thawing or deicing chemicals shall be air entrained in accordance with ACI 318, Section 4.2.1:

1904.2.2 Concrete properties. Concrete that will be subject to the following exposures shall conform to the corresponding maximum water-cementitious materials ratios and minimum specified concrete compressive strength requirements of ACI 318, Section 4.2.2:

1. Concrete intended to have low permeability where exposed to water;
2. Concrete exposed to freezing and thawing in a moist condition or deicer chemicals; or
3. Concrete with reinforcement where the concrete is exposed to chlorides from deicing chemicals, salt, salt water, brackish water, seawater or spray from these sources.

Exception: *For occupancies and appurtenances thereto in Group R occupancies that are in buildings less than four stories in height, normal-weight aggregate concrete shall comply with the require-*

TABLE 720.1(2)—continued
RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS [a,o,p]

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE[b] (inches)			
			4 hour	3 hour	2 hour	1 hour
15. Exterior or interior walls (continued)	15-1.9	4″ No. 18 gage, nonload-bearing metal studs, 16″ on center, with 1″ portland cement lime plaster [measured from the back side of the 3/4-pound expanded metal lath] on the exterior surface. Interior surface to be covered with 1″ of gypsum plaster on 3/4-pound expanded metal lath proportioned by weight—1:2 for scratch coat, 1:3 for brown, gypsum to sand. Lath on one side of the partition fastened to 1/4″ diameter pencil rods supported by No. 20 gage metal clips, located 16″ on center vertically, on each stud. 3″ thick mineral fiber insulating batts friction fitted between the studs.	—	—	6 1/2[d]	—
	15-1.10	Steel studs 0.060″ thick, 4″ deep or 6″ at 16″ or 24″ centers, with 1/2″ Glass Fiber Reinforced Concrete (GFRC) on the exterior surface. GFRC is attached with flex anchors at 24″ on center, with 5″ leg welded to studs with two 1/2″-long flare-bevel welds, and 4″ foot attached to the GFRC skin with 5/8″ thick GFRC bonding pads that extend 2 1/2″ beyond the flex anchor foot on both sides. Interior surface to have two layers of 1/2″ Type X gypsum wallboard.[e] The first layer of wallboard to be attached with 1″-long Type S buglehead screws spaced 24″ on center and the second layer is attached with 1 5/8″-long Type S screws spaced at 12″ on center. Cavity is to be filled with 5″ of 4 pcf (nominal) mineral fiber batts. GFRC has 1 1/2″ returns packed with mineral fiber and caulked on the exterior.	—	—	6 1/2	—
	15-1.11	Steel studs 0.060″ thick, 4″ deep or 6″ at 16″ or 24″ centers, respectively, with 1/2″ Glass Fiber Reinforced Concrete (GFRC) on the exterior surface. GFRC is attached with flex anchors at 24″ on center, with 5″ leg welded to studs with two 1/2″-long flare-bevel welds, and 4″ foot attached to the GFRC skin with 5/8″-thick GFRC bonding pads that extend 2 1/2″ beyond the flex anchor foot on both sides. Interior surface to have one layer of 5/8″ Type X gypsum wallboard[e], attached with 1 1/4″-long Type S buglehead screws spaced 12″ on center. Cavity is to be filled with 5″ of 4 pcf (nominal) mineral fiber batts. GFRC has 1 1/2″ returns packed with mineral fiber and caulked on the exterior.	—	—	—	6 1/8
	15-1.12[q]	2″ × 6″ wood studs at 16″ with double top plates, single bottom plate; interior and exterior sides covered with 5/8″ Type X gypsum wallboard, 4′ wide, applied horizontally or vertically with vertical joints over studs, and fastened with 2 1/4″ Type S drywall screws, spaced 12″ on center.	—	—	—	6 3/4
	15-1.13[q]	2″ × 6″ wood studs at 16″ with double top plates, single bottom plate; interior and exterior sides covered with 5/8″ Type X gypsum wallboard, 4′ wide, applied vertically with all joints over framing or blocking and fastened with 2 1/4″ Type S drywall screws, spaced 12″ on center. R-19 fiberglass insulation installed in stud cavity.	—	—	—	6 3/4
	15-1.14[q]	2″ × 6″ wood studs at 16″ with double top plates, single bottom plate; interior and exterior sides covered with 5/8″ Type X gypsum wallboard, 4′ wide, applied horizontally or vertically with vertical joints over studs, and fastened with 2 1/4″ Type S drywall screws, spaced 7″ on center.	—	—	—	6 3/4
	15-1.15[q]	2″ × 4″ wood studs at 16″ with double top plates, single bottom plate; interior and exterior sides covered with 5/8″ Type X gypsum wallboard and sheathing, respectively, 4′ wide, applied horizontally or vertically with vertical joints over studs, and fastened with 2 1/4″ Type S drywall screws, spaced 12″ on center. Cavity to be filled with 3 1/2″ mineral wool insulation.	—	—	—	4 3/4
	15-1.16[q]	2″ × 6″ wood studs at 24″ centers with double top plates, single bottom plate; interior and exterior side covered with two layers of 5/8″ Type X gypsum wallboard, 4′ wide, applied horizontally with vertical joints over studs. Base layer fastened with 2 1/4″ Type S drywall screws, spaced 8″ on center, wallboard joints covered with paper tape and joint compound, fastener heads covered with joint compound. Cavity to be filled with 5 1/2″ mineral wool insulation.	—	—	—	4 1/2

(continued)