

CHAPTER 19
CONCRETE

SECTION BC 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 1911, 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. Sections 1902 through 1907 of this chapter are derived from the provisions for structural concrete in ACI 318. Where sections within Chapters 2 through 7 of ACI 318 are referenced in other chapters and appendices of ACI 318, the provisions of Sections 1902 through 1907 of this code shall apply.

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

1. Specified compressive strength of concrete at the stated ages or stages of construction for which each concrete element is designed.
2. Specified strength or grade of reinforcement.
3. Size and location of structural elements, reinforcement, and anchors.
4. Provision for dimensional changes resulting from creep, shrinkage and temperature.
5. 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, a statement if slab on

- grade is designed as a structural diaphragm (see Section 21.10.3.4 of ACI 318).
12. Freezing and thawing and deicing chemical exposure classifications (see Section 1904.2).
13. Sulfate exposure classification (see Section 1904.3).
14. Maximum water soluble chloride ion (CI) concentrations (see Section 1904.4).

1901.5 Special inspection. The special inspection of concrete elements of buildings and structures and concreting operations shall be in accordance with Chapter 17.

SECTION BC 1902 **DEFINITIONS**

1902.1 General. The following words and terms shall have the meanings shown herein.

ADMIXTURE. Material other than water, aggregate or hydraulic cement, used as an ingredient of concrete and added to concrete before or during its mixing to modify its properties.

AGGREGATE. Granular material, such as sand, gravel, crushed stone and iron blast-furnace slag, used with a cementing medium to form a hydraulic cement concrete or mortar.

AGGREGATE, LIGHTWEIGHT. Aggregate with a dry, loose weight of 70 pounds per cubic foot (pcf) (1120 kg/m³) or less.

CEMENTITIOUS MATERIALS. Materials as specified in Section 1903 that have cementing value when used in concrete either by themselves, such as portland cement, blended hydraulic cements and expansive cement, or such materials in combination with fly ash, other raw or calcined natural pozzolans, silica fume, and/or ground granulated blast-furnace slag.

COLUMN. A member with a ratio of height-to-least-lateral dimension exceeding three, used primarily to support axial compressive load.

CONCRETE. A mixture of portland cement or any other hydraulic cement, fine aggregate, coarse aggregate and water, with or without admixtures.

CONCRETE, SPECIFIED COMPRESSIVE STRENGTH OF, (f'_c). The compressive strength of concrete used in design and evaluated in accordance with the provisions of Section 1905, expressed in pounds per square inch (psi) (MPa). Whenever the quantity f'_c is under a radical sign, the square root of the numerical value only is intended, and the result has units of psi (MPa).

CONTRACTION JOINT. Formed, sawed or tooled groove in a concrete structure to create a weakened plane and regulate the location of cracking resulting from the dimensional change of different parts of the structure.

DEFORMED REINFORCEMENT. Deformed reinforcing bars, bar mats, deformed wire, welded plain wire fabric and welded deformed wire fabric conforming to ACI 318, Section 3.5.3.

DUCT. A conduit (plain or corrugated) to accommodate prestressing steel for postensioned installation.

EFFECTIVE DEPTH OF SECTION (d). The distance measured from extreme compression fiber to the centroid of tension reinforcement.

ISOLATION JOINT. A separation between adjoining parts of a concrete structure, usually a vertical plane, at a designed location such as to interfere least with performance of the structure, yet to allow relative movement in three directions and avoid formation of cracks elsewhere in the concrete and through which all or part of the bonded reinforcement is interrupted.

PEDESTAL. An upright compression member with a ratio of unsupported height-to-average-least-lateral dimension of three or less.

PLAIN CONCRETE. Structural concrete with no reinforcement or with less reinforcement than the minimum amount specified for reinforced concrete.

PLAIN REINFORCEMENT. Reinforcement that does not conform to the definition of “Deformed reinforcement” (see ACI 318, Section 3.5.4).

POSTTENSIONING. Method of prestressing in which prestressing steel is tensioned after concrete has hardened.

PRECAST CONCRETE. A structural concrete element cast elsewhere than its final position in the structure.

PRESTRESSED CONCRETE. Structural concrete in which internal stresses have been introduced to reduce potential tensile stresses in concrete resulting from loads.

PRESTRESSING STEEL. High-strength steel element such as wire, bar or strand, or a bundle of such elements, used to impart prestress forces to concrete.

PRETENSIONING. Method of prestressing in which prestressing steel is tensioned before concrete is placed.

REINFORCED CONCRETE. Structural concrete reinforced with no less than the minimum amounts of prestressing steel or nonprestressed reinforcement specified in ACI

318, Chapters 1 through 21 and ACI 318 Appendices A through C.

REINFORCEMENT. Material that conforms to Section 1903.5, excluding prestressing steel unless specifically included.

RESHORES. Shores placed snugly under a concrete slab or other structural member after the original forms and shores have been removed from a larger area, thus requiring the new slab or structural member to deflect and support its own weight and existing construction loads applied prior to the installation of the reshores.

SHORES. Vertical or inclined support members designed to carry the weight of the formwork, concrete and construction loads above.

SPIRAL REINFORCEMENT. Continuously wound reinforcement in the form of a cylindrical helix.

STRIPPING OPERATIONS. Removal on the floor of any parts of the concrete formwork including shoring, bracing and other supports.

STIRRUP. Reinforcement used to resist shear and torsion stresses in a structural member; typically bars, wires or welded wire fabric (plain or deformed) either single leg or bent into L, U or rectangular shapes and located perpendicular, or at an angle to, longitudinal reinforcement. (The term “stirrups” is usually applied to lateral reinforcement in flexural members and the term “ties” to those in compression members.)

STRUCTURAL CONCRETE. Concrete used for structural purposes, including plain and reinforced concrete.

TENDON. In pretensioning applications, the tendon is the prestressing steel. In posttensioned applications, the tendon is a complete assembly consisting of anchorages, prestressing steel and sheathing with coating for unbonded applications or ducts with grout for bonded applications.

SECTION BC 1903 **SPECIFICATIONS FOR TESTS AND MATERIALS**

1903.1 General. Materials used to produce concrete and testing thereof shall comply with the applicable standards listed in ACI 318 and this section. Tests of concrete and the materials used in concrete shall be in accordance with ACI 318, Section 3.8. Where required, special inspections and tests shall be in accordance with Chapter 17.

1903.2 Cement. Cement used to produce concrete shall comply with ACI 318, Section 3.2.

1903.3 Aggregates. Aggregates used in concrete shall comply with ACI 318, Section 3.3.

1903.4 Water. Water used in mixing concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials or other substances that are deleterious to concrete or steel reinforcement and shall comply with ACI 318, Section 3.4.

1903.5 Steel reinforcement. Reinforcement and welding of reinforcement to be placed in concrete construction shall conform to the requirements of this section.

1903.5.1 Reinforcement type. Reinforcement shall be deformed reinforcement, except plain reinforcement is permitted for spirals or prestressing steel, and reinforcement consisting of structural steel, steel pipe or steel tubing is permitted where specified in ACI 318. Reinforcement shall comply with ACI 318, Section 3.5.

1903.5.2 Welding. Welding of reinforcing bars shall conform to AWS D1.4. Type and location of welded splices and other required welding of reinforcing bars shall be indicated on the construction documents or in the project specifications. The ASTM reinforcing bar specifications, except for ASTM A 706, shall be supplemented to require a report of material properties necessary to conform to the requirements in AWS D1.4. A written welding procedure shall be provided to the registered design professional of record for approval prior to any welding. All welding shall be subject to special inspection by an approved agency.

1903.6 Admixtures. Admixtures to be used in concrete shall be subject to prior approval by the registered design professional of record and shall comply with ACI 318, Section 3.6.

1903.7 Storage of materials. The storage of materials for use in concrete shall comply with the provisions of Sections 1903.7.1 and 1903.7.2.

1903.7.1 Manner of storage. Cementitious materials and aggregates shall be stored in such a manner as to prevent deterioration or intrusion of foreign matter.

1903.7.2 Unacceptable material. Any material that has deteriorated or has been contaminated shall not be used for concrete.

1903.8 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 BC 1904 **DURABILITY REQUIREMENTS**

1904.1 Water-cementitious materials ratio. The water-cementitious materials ratios specified in Tables 1904.2.2 and 1904.3 shall be calculated using the weight of cement meeting ASTM C 150, ASTM C 595, ASTM C 845 or ASTM C 1157, plus the weight of fly ash and other pozzolans meeting ASTM C 618, slag meeting ASTM C 989 and silica fume meeting ASTM C 1240, if any, except that where concrete is exposed to deicing chemicals, Section 1904.2.3 further limits the amount of fly ash, pozzolans, silica fume,