

# CHAPTER 19—CONCRETE: DESIGN AND DURABILITY REQUIREMENTS

## CODE COMMENTARY

### 19.1—Scope

**19.1.1** This chapter shall apply to concrete, including:

- (a) Properties to be used for design
- (b) Durability requirements

**19.1.2** This chapter shall apply to durability requirements for grout used for bonded tendons in accordance with 19.4.

### 19.2—Concrete design properties

#### 19.2.1 Specified compressive strength

**19.2.1.1** The value of  $f'_c$  shall be in accordance with (a) through (d):

- (a) Limits for  $f'_c$  in Table 19.2.1.1. Limits apply to both normalweight and lightweight concrete.
- (b) Durability requirements in Table 19.3.2.1
- (c) Structural strength requirements
- (d)  $f'_c$  for lightweight concrete in special moment frames and special structural walls, and their foundations, shall not exceed 35 MPa, unless demonstrated by experimental evidence that members made with lightweight concrete provide strength and toughness equal to or exceeding those of comparable members made with normalweight concrete of the same strength.

**Table 19.2.1.1—Limits for  $f'_c$**

Application	Minimum $f'_c$ , MPa
General	17
Foundations for structures assigned to SDC A, B, or C	17
Foundations for Residential and Utility use and occupancy classification with stud bearing wall construction two stories or less assigned to SDC D, E, or F	17
Foundations for structures assigned to SDC D, E, or F other than Residential and Utility use and occupancy classification with stud bearing wall construction two stories or less	21
Special moment frames	21
Special structural walls with Grade 420 or 550 reinforcement	35
Special structural walls with Grade 690 reinforcement	35
Precast-nonprestressed driven piles	28
Drilled shafts	28
Precast-prestressed driven piles	35

**19.2.1.2** The specified compressive strength shall be used for proportioning of concrete mixtures in 26.4.3 and for testing and acceptance of concrete in 26.12.3.

**19.2.1.3** Unless otherwise specified,  $f'_c$  shall be based on 28-day tests. If other than 28 days, test age for  $f'_c$  shall be indicated in the construction documents.

#### 19.2.2 Modulus of elasticity

### R19.2—Concrete design properties

#### R19.2.1 Specified compressive strength

Requirements for concrete mixtures are based on the philosophy that concrete should provide both adequate strength and durability. The Code defines a minimum value of  $f'_c$  for structural concrete. There is no limit on the maximum value of  $f'_c$  except as required by specific Code provisions.

Concrete mixtures proportioned in accordance with 26.4.3 should achieve an average compressive strength that exceeds the value of  $f'_c$  used in the structural design calculations. The amount by which the average strength of concrete exceeds  $f'_c$  is based on statistical concepts. When concrete is designed to achieve a strength level greater than  $f'_c$ , it ensures that the concrete strength tests will have a high probability of meeting the strength acceptance criteria in 26.12.3. The durability requirements prescribed in Table 19.3.2.1 are to be satisfied in addition to meeting the minimum  $f'_c$  of 19.2.1. Under some circumstances, durability requirements may dictate a higher  $f'_c$  than that required for structural purposes.

Available test data do not include lower strength concrete with Grade 690 reinforcement in special structural walls (refer to R18.2.6).

For design of special moment frames and special structural walls used to resist earthquake forces, the Code limits the maximum  $f'_c$  of lightweight concrete to 35 MPa. This limit is imposed primarily because of a paucity of experimental and field data on the behavior of members made with lightweight concrete subjected to displacement reversals in the nonlinear range.

Minimum concrete strengths are increased for special seismic systems with  $f_y > 550$  MPa to enhance bar anchorage and reduce the neutral axis depth for improved performance.

The Code also limits  $f'_c$  for design of anchors to concrete. The requirements are in 17.3.1.

#### R19.2.2 Modulus of elasticity