

## CODE

**7.6.6.5** — Where spacing limitations and minimum concrete cover are based on bar diameter,  $d_b$ , a unit of bundled bars shall be treated as a single bar of a diameter derived from the equivalent total area.

**7.6.7 — Tendons and ducts**

**7.6.7.1** — Center-to-center spacing of pretensioning tendons at each end of a member shall be not less than  $4d_b$  for strands, or  $5d_b$  for wire, except that if specified compressive strength of concrete at time of initial prestress,  $f'_{ci}$ , is 4000 psi or more, minimum center-to-center spacing of strands shall be 1-3/4 in. for strands of 1/2 in. nominal diameter or smaller and 2 in. for strands of 0.6 in. nominal diameter. See also **3.3.2**. Closer vertical spacing and bundling of tendons shall be permitted in the middle portion of a span.

**7.6.7.2** — Bundling of post-tensioning ducts shall be permitted if shown that concrete can be satisfactorily placed and if provision is made to prevent the prestressing steel, when tensioned, from breaking through the duct.

**7.7 — Concrete protection for reinforcement****7.7.1 — Cast-in-place concrete (nonprestressed)**

The following minimum concrete cover shall be provided for reinforcement, but shall not be less than required by **7.7.5** and **7.7.7**:

	Minimum cover, in.
(a) Concrete cast against and permanently exposed to earth .....	3
(b) Concrete exposed to earth or weather:	
No. 6 through No. 18 bars .....	2
No. 5 bar, W31 or D31 wire, and smaller .....	1-1/2
(c) Concrete not exposed to weather or in contact with ground:	
Slabs, walls, joists:	
No. 14 and No. 18 bars .....	1-1/2
No. 11 bar and smaller .....	3/4

## COMMENTARY

preclude bundling more than two bars in the same plane. Typical bundle shapes are triangular, square, or L-shaped patterns for three- or four-bar bundles. As a practical caution, bundles more than one bar deep in the plane of bending should not be hooked or bent as a unit. Where end hooks are required, it is preferable to stagger the individual bar hooks within a bundle.

**R7.6.7 — Tendons and ducts**

**R7.6.7.1** — The allowed decreased spacing in this section for transfer strengths of 4000 psi or greater is based on **Reference 7.10, 7.11**.

**R7.6.7.2** — When ducts for prestressing steel in a beam are arranged closely together vertically, provision should be made to prevent the prestressing steel from breaking through the duct when tensioned. Horizontal disposition of ducts should allow proper placement of concrete. A clear spacing of one and one-third times the size of the coarse aggregate, but not less than 1 in., has proven satisfactory. Where concentration of tendons or ducts tends to create a weakened plane in the concrete cover, reinforcement should be provided to control cracking.

**R7.7 — Concrete protection for reinforcement**

Concrete cover as protection of reinforcement against weather and other effects is measured from the concrete surface to the outermost surface of the steel to which the cover requirement applies. Where minimum cover is prescribed for a class of structural member, it is measured to the outer edge of stirrups, ties, or spirals if transverse reinforcement encloses main bars; to the outermost layer of bars if more than one layer is used without stirrups or ties; or to the metal end fitting or duct on post-tensioned prestressing steel.

The condition “concrete surfaces exposed to earth or weather” refers to direct exposure to moisture changes and not just to temperature changes. Slab or thin shell soffits are not usually considered directly exposed unless subject to alternate wetting and drying, including that due to condensation conditions or direct leakage from exposed top surface, run off, or similar effects.

Alternative methods of protecting the reinforcement from weather may be provided if they are equivalent to the additional concrete cover required by the code. When approved by the building official under the provisions of **1.4**, reinforcement with alternative protection from the weather may

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Beams, columns:

Primary reinforcement, ties,  
stirrups, spirals ..... 1-1/2

Shells, folded plate members:

No. 6 bar and larger ..... 3/4  
No. 5 bar, W31 or D31 wire,  
and smaller ..... 1/2

### 7.7.2 — Cast-in-place concrete (prestressed)

The following minimum concrete cover shall be provided for prestressed and nonprestressed reinforcement, ducts, and end fittings, but shall not be less than required by 7.7.5, 7.7.5.1, and 7.7.7:

Minimum  
cover, in.

(a) Concrete cast against and  
permanently exposed to earth ..... 3

(b) Concrete exposed to earth or weather:

Wall panels, slabs, joists ..... 1  
Other members ..... 1-1/2

(c) Concrete not exposed to  
weather or in contact with ground:

Slabs, walls, joists ..... 3/4  
Beams, columns:  
Primary reinforcement ..... 1-1/2  
Ties, stirrups, spirals ..... 1

Shells, folded plate members:

No. 5 bar, W31 or D31 wire,  
and smaller ..... 3/8  
Other reinforcement .....  $d_b$  but not  
less than 3/4

### 7.7.3 — Precast concrete (manufactured under plant control conditions)

The following minimum concrete cover shall be provided for prestressed and nonprestressed reinforcement, ducts, and end fittings, but shall not be less than required by 7.7.5, 7.7.5.1, and 7.7.7:

Minimum  
cover, in.

(a) Concrete exposed to earth or weather:

Wall panels:

No. 14 and No. 18 bars, prestressing  
tendons larger than 1-1/2 in.  
diameter ..... 1-1/2  
No. 11 bar and smaller, prestressing  
tendons 1-1/2 in. diameter and smaller,  
W31 and D31 wire and smaller ..... 3/4

## COMMENTARY

have concrete cover not less than the cover required for reinforcement not exposed to weather.

The development length given in Chapter 12 is now a function of the bar cover. As a result, it may be desirable to use larger than minimum cover in some cases.

### R7.7.3 — Precast concrete (manufactured under plant control conditions)

The lesser cover thicknesses for precast construction reflect the greater convenience of control for proportioning, placing, and curing inherent in precasting. The term “manufactured under plant control conditions” does not specifically imply that precast members should be manufactured in a plant. Structural elements precast at the job site will also qualify under this section if the control of form dimensions, placing of reinforcement, quality control of concrete, and curing procedure are equal to that normally expected in a plant.

Concrete cover to pretensioned strand as described in this section is intended to provide minimum protection against weather and other effects. Such cover may not be sufficient to transfer or develop the stress in the strand, and it may be necessary to increase the cover accordingly.