

## CHAPTER 10 REINFORCING STEEL

### 10-1 General

Design details of reinforcing steel, unless otherwise modified herein, shall comply with the requirements of the AASHTO Standard Specifications. When detailing reinforcing steel, consideration should be exercised to keep the number of bends in a bar to a minimum, to eliminate hooks if possible, and to use as few different bars as possible. It is important to note that the bar count for any structural element shall be shown in only one view and only the bar mark called out in other views.

### 10-2 Bar Sizes

All reinforcing steel shall be deformed bars. Use the bar number on all drawings to indicate bar sizes as follows:

Bar Size Designation	Nominal Diameter	Approximate Diameter Outside Deformations
<u>#3</u> (#10)	<u>3/8"</u> (9.5 mm)	<u>7/16"</u> (11.1 mm)
<u>#4</u> (#13)	<u>1/2"</u> (12.7 mm)	<u>9/16"</u> (14.3 mm)
<u>#5</u> (#16)	<u>5/8"</u> (15.9 mm)	<u>11/16"</u> (17.5 mm)
<u>#6</u> (#19)	<u>3/4"</u> (19.1 mm)	<u>7/8"</u> (22.2 mm)
<u>#7</u> (#22)	<u>7/8"</u> (22.2 mm)	<u>1"</u> (25.4 mm)
<u>#8</u> (#25)	<u>1"</u> (25.4 mm)	<u>1 1/8"</u> (28.6 mm)
<u>#9</u> (#29)	<u>1 1/8"</u> (28.7 mm)	<u>1 1/4"</u> (31.8 mm)
<u>#10</u> (#32)	<u>1 1/4"</u> (32.3 mm)	<u>1 7/16"</u> (36.5 mm)
<u>#11</u> (#36)	<u>1 7/16"</u> (35.8 mm)	<u>1 5/8"</u> (41.3 mm)
<u>#14</u> (#43)	<u>1 11/16"</u> (43.0 mm)	<u>1 7/8"</u> (47.6 mm)
<u>#18</u> (#57)	<u>2 1/4"</u> (57.3 mm)	<u>2 1/2"</u> (63.5 mm)

For additional bar properties and steel areas, see Figures 10-1 and 10-2.

### 10-3 Placing Steel

**Detailing** Indicate the reinforcing steel in concrete sections with a single broken line. When dimensioning reinforcing bars from concrete surfaces, show clear dimensions. Show the dimensions between reinforcing bars as center to center. The center to center distance between parallel bars is measured perpendicular to the longitudinal axis of the bars.

Provide reinforcement for shrinkage and temperature stresses near the exposed surfaces of walls and slabs otherwise unreinforced. Space this reinforcement at a maximum of 18 inches (450 mm).

For cast-in-place concrete, the clear distance between parallel bars shall not be less than 1.5 times the nominal diameter of the bars, 1.5 times the maximum size of the coarse aggregate, or 1½ inches (38 mm).

In detailing the ‘A’ bars in bridge decks, show on the plans the dimension from the work points to the first full length ‘A’ bars. Place the top mat ‘A’ bars directly above the bottom mat ‘A’ bars. Do not stagger these transverse bars.

When spacing the top longitudinal bars in a bent cap, avoid interference with the anchor bolts and the 4 inches (102 mm)  $\phi$  pipes.

---

**Bar Supports** Bar supports are required in a number of locations on bridges. In general, it will be necessary to provide supports for reinforcing steel in deck slabs and overhangs, railings, bent diaphragms, intermediate diaphragms, bent caps, approach slabs and culvert slabs. It is not necessary to detail bar supports in the backwalls, parapets, sidewalks, footings, or vertical walls of culverts.

Figures are included throughout this manual as a general guide to detail these bar supports. Use the outside bar deformations, in lieu of nominal bar diameters, in setting clear dimensions and the heights of bar supports. For outside bar deformations, see Section 10-2. Detail a definitive spacing for bar supports rather than a “maximum” spacing. Bar support heights shall be detailed to the nearest ¼ inch increment and shown to the nearest ¼ inch (1 mm).

Show the location and height of beam bolsters in deck slab overhangs as shown in Figures 6-20 and 6-22. The beam bolsters shall be located 1 foot (300 mm) from the outside edge of superstructure. When prestressed concrete panels are used, two bar supports shall be shown in the slab overhangs.

The type of supports used should be standardized as much as possible. References for detailing bar supports include the CRSI “Manual of Standard Practice” and literature distributed by the manufacturers.

---

**Concrete Cover** The following table shall be used to determine the minimum cover to main reinforcement, unless stated otherwise, for various structure elements:

Structure Element	Cover	
	All Other Sites	Corrosive Sites
Bridge Deck to top of slab to bottom of slab	<u>2 ½"</u> (65 mm) <u>1 ¼"</u> ( <del>30</del> <u>32</u> mm)	<u>2 ½"</u> (65 mm) <u>1 ¼"</u> ( <del>30</del> <u>32</u> mm)*
Footings and Pile Caps to top face to all other faces	<u>2"</u> (50 mm) <u>3"</u> (75 mm)	<u>4"</u> (100 mm) <u>4"</u> (100 mm)
Bent Caps to bottom of cap to ends of cap to top of cap (stirrups) to sides of cap (stirrups)	<u>3"</u> (75 mm) <u>2"</u> (50 mm) <u>2"</u> (50 mm) <u>2"</u> (50 mm)	<u>4"</u> (100 mm) <u>3"</u> (75 mm) <u>3"</u> (75 mm) <u>3"</u> (75 mm)
Columns (spiral)	<u>2"</u> (50 mm)	<u>3"</u> (75 mm)
Drilled Piers (spiral)	<u>5"</u> (125 mm)**	<u>6"</u> (150 mm)**
Culverts to bottom of bottom slabs and footings to all other faces	<u>3"</u> (75 mm) <u>2"</u> (50 mm)	<u>3"</u> (75 mm) <u>2"</u> (50 mm)
Approach Slabs	<u>2"</u> (50 mm)	<u>2"</u> (50 mm)

\* When using removable forms, cover shall be increased to 2 ½ inches (65 mm).

\*\* In the event the drilled pier extends into a bent cap or pile cap, the cover may be reduced to 4 inches (100 mm).

For structures at Corrosive Sites, refer to Section 12-13.

### Basic Development and Splice Lengths

For bars in tension, bar splices and development lengths should be in accordance with Figures 10-3 and 10-4.

For bars in compression, the bar splice and development length should be in accordance with Figure 10-5.

For superstructures, show the splice length chart of Figure 10-6 on the plans.

For a guide to substructure splice length and the required embedment of 'V' bars into the cap, see Figures 10-7 and 10-8. Show the splice length for bars in the substructure units on the plans at each splice.

For reinforced concrete box culverts, obtain the splice length chart from the Culvert Design computer program and include on the plans.

#### 10-4 Detailing Reinforcing Bars

**Bill of Material** The bar schedules and types should be enclosed in a Bill of Material as shown in Figure 10-9. The Superstructure Bill of Material shall have a breakdown of reinforcing steel for each span or continuous unit. Do not repeat deck reinforcing bar designations in different spans unless the bars are identical in size, length and shape.

Bar nomenclature shall remain the same as that already in use rather than as recommended in the ACI Manual.

**Bar Schedule** All reinforcing bars should be listed in the Bar Schedule in the following manner:

<u>Bar</u>	<u>No.</u>	<u>Size</u>	<u>Type</u>	<u>Length</u>	<u>Weight</u>
------------	------------	-------------	-------------	---------------	---------------

Weights shall be shown to the nearest **1b (kg)**. Programs are available that will compute the bar weights and list the results in a format suitable for inclusion in the plans. For example, see Figure 10-9.

**Bar Bending Diagrams** Bar bending diagrams and details shall be made in accordance with the recommendations of the ACI "Manual of Standard Practice for Detailing Reinforced Concrete Structures".

Bar bending details should be to the nearest **¼ inch (5 mm)** and bar lengths should be shown to the nearest **inch (20 mm)**. The dimensions for bent bars shall be out-to-out dimensions and noted as such in the bending diagram, see Figure 10-10. The bending diagrams shall be titled "Bar Types" in the plans.

Particular attention is called to the standard hook details in the above listed manual and as shown in Figure 10-11. Reinforcing bars shall be provided with hooks as required by design.

**Maximum Bar Lengths** The maximum length shall be **30 feet (9 m)** for **#3 (#10)** and **#4 (#13)** bars and **60 feet (18 m)** for all other bar sizes. For ease of shipping, avoid detailing only one or two bars in a bridge **60 feet (18 m)** long while the other bars are much shorter.

---

### 10-5 Epoxy Coated Reinforcing Steel

As a minimum corrosion protection measure, all reinforcing steel in sidewalks, barrier rails, and concrete medians shall be epoxy coated. In addition, the top mat of steel for all bridge decks and approach slabs, and the stirrups and longitudinal reinforcing steel in the end diaphragms shall be epoxy coated.

At Corrosive Sites as defined by Figure 12-16a, the reinforcing steel, bar supports, and incidental steel for all cast-in-place concrete elements shall be epoxy coated.

For precast and cast-in-place culverts east of the Corrosive (blue) line of Figure 12-17, all reinforcing steel and bar supports shall be epoxy coated. For the note regarding bar supports and incidental steel, see Section 12-13 “Corrosion Protection Measures”.

For bridge widening projects, epoxy coated reinforcing steel shall be used in the proposed section of the bridge. When latex modified concrete is used, do not use epoxy coated reinforcing steel.