

Subsection 4.12 Reinforcing Steel

I. Scope: This item includes the furnishing and placing of reinforcing steel, deformed and smooth, of the size and quantity designated and in accordance with these specifications and with plan details.

II. Materials

A. Unless otherwise designated on the plans, or herein, all bar reinforcement shall be deformed, and shall conform to 1 of the following:

1. ASTM A 615, Grade 60, open hearth, basic oxygen, or electric furnace new billet steel, or ASTM 617, Grade 60, axle-steel;
2. Where bending or bar sizes No. 14 or No. 18 of Grade 60 is required, bend testing shall be performed on representative specimens as described for smaller bars in the applicable ASTM Specification. The required bend shall be 90° around a pin having a diameter of 10 times the nominal diameter of the bar.

Spiral reinforcement shall be either smooth or deformed bars, or wire, of the minimum size or gage shown on the plans. Bars for spiral reinforcement shall comply with ASTM A 675, A 615 or A 617. Wire shall comply with ASTM A 82.

Unless otherwise shown on the plans the minimum yield strength for spiral reinforcement shall be 40,000 pounds per square inch.

Report of chemical analysis, showing the percentages of carbon, manganese, phosphorus and sulfur will be required for all reinforcing steel.

Smooth bars, larger than No. 4, may be furnished in any steel that meets the physical requirements of ASTM A36.

Smooth round bars shall be designated by size number through No.4. Smooth bars above No.4 shall be designated by diameter inches.

Wire fabric reinforcement shall be cold-drawn from rods hot-rolled from open hearth, basic oxygen, or electric furnace billeted. Wire shall conform to the requirements of the Standard Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement, ASTM A82 or A496. Wire fabric, when used as reinforcement, shall conform to ASTM A185 or A497.

B. Bending: The reinforcement shall be bent cold, true to the shapes indicated on the plans. Bending shall preferably be done in the shop. Irregularities in bending shall be cause for rejection. Unless otherwise shown in the plans, inside diameter of bar bends, in terms of the nominal bar diameter (d), must be as shown in

Table 1.

Table 1
Minimum Inside Diameter of Bar Bends

Bend	Bar Size Number (in.)	Bar Size Number (mm)	Diameter
Bends of 90° and greater in stirrups, ties, and other secondary bars that enclose another bar in the bend	3, 4, 5	10, 13, 16	4d
	6, 7, 8	19, 22, 25	6d
Bends in main bars and in secondary bars not covered above	3 through 8	10 Through 25	6d
	9, 10, 11	29, 32, 26	8d
	14, 18	43, 57	10d

C. Tolerances: Fabricating tolerances for bars, from plan dimensions, shall not be greater than ASTM requirements.

D. Storing: Steel reinforcement shall be stored above the surface of the ground upon platforms, skids, or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, paint, grease, oil, or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross sectional area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel specified.

E. Splices: No splicing bars, except when provided on the plans, or, specified herein, will be permitted without written approval of the Engineer.

Splices not provided for on the plans will be permitted in slabs not more than 15 inches in thickness, columns, walls and parapets, but not included for measurement, subject to the following:

Splices will not be permitted in bars 30 feet or less in plan length. For bars exceeding 30 feet in plan length, the distance center to center of splices shall not be less than 30 feet minus splice length, with no more than 1 individual bar length less than 10 feet. Splices not shown on the plans, but permitted hereby, shall be made in accordance with Table 2. The specified concrete cover shall be maintained at such splices and the bars placed in contact and securely tied together.

**Table 2
Minimum Lap Length**

Bar Size Number (in.)	Bar Size Number (mm)	Uncoated Lap Length	Coated Lap Length	Weight per foot
3	10	1'-0"	2'-0"	0.376
4	13	1'-9"	2'-8"	0.668
5	16	2'-2"	3'-3"	1.043
6	19	2'-7"	3'-11"	1.502
7	22	3'-5"	5'-2"	2.044
8	25	4'-6"	6'-9"	2.670
9	29	5'-8"	8'-6"	3.400
10	32	7'-3"	10'-11"	4.303
11	36	8'-11"	13'-5"	5.313

Spiral steel shall be lapped a minimum of 1 turn. Sizes No. 14 and No. 18 may not be lapped.

Welding of reinforcing bars may be done only where shown on the plans or as permitted herein. All welding operations, process, equipment, materials, workmanship, and inspection shall conform to the requirements of the plans. All splices shall be of such dimension and character as to develop the full strength of the bar being spliced.

End preparation for butt welding reinforcing bars, shall be done in the field. Delivered bars shall be of sufficient length to permit this practice.

F. Welded Wire Fabric: For wire reinforcement, use wire that conforms to ASTM A185 or A497. Observe the relations shown in Table 3 among size number, diameter in inches, and area ordering wire by size numbers. Precede the size number for deformed wire with a "D" and smooth wire with "W."

Designate welded wire fabric as shown in the following example: 6 x 12 - W16 x W8 (indicating 6 inch longitudinal wire spacing and 12 inch transverse wire spacing and 12 inch transverse wire spacing with smooth No. 16 wire longitudinally and smooth No8 wire transversely).

Table 3
Wire Size Number, Diameter, and Area

Wire Size Number (in.)	Wire Size Number (mm)	Diameter (in.)	Area (sq. in.)
24	155	0.553	0.240
22	142	0.529	0.220
20	129	0.505	0.200
18	116	0.479	0.180
16	103	0.451	0.160
14	90	0.422	0.140
12	77	0.391	0.120
10	65	0.357	0.100
8	52	0.319	0.080
7	45	0.299	0.070
6	39	0.276	0.060

G. Epoxy Coating: Epoxy coating will be required when shown in the plans. Coat reinforcing steel in accordance with Table 4. Patch damaged epoxy coating with approved material. Maintain identification of all reinforcement throughout the coating and fabrication and until delivery to the project site. Furnish 1 copy of a written certification that the coated reinforcing steel meets the requirements of the Subsection and 1 copy of the manufacturer's control tests.

Table 4
Epoxy Coating Requirements for Reinforcing Steel

Material	Specification
Bar	ASTM A 775 or A 934
Wire	ASTM A 884 Class A or B

H. Mechanical Couplers: When mechanical splices in reinforcing steel bars are shown on the plans, use the following types of coupler:

1. Sleeve filler;
2. Sleeve threaded;
3. Sleeve swaged; or
4. Sleeve wedge.

I. Placing: Unless otherwise shown on the plans, dimensions shown for reinforcement are to the centers of the bars. Reinforcement shall be placed as near as possible in the position shown on the plans. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from the plan placement by more than 1/12 of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars shall not vary from plan placement by more than 1/4.

Cover of concrete to the nearest surface of steel shall meet the above requirements but shall never be less than 2 inches.

The reinforcement shall be accurately located in the forms, and firmly held in place, before and during concrete placement, by means of bar supports, adequate in strength and number to prevent displacement, to keep the steel at the proper distance from the forms and to carry the reinforcing bars they support. Bars shall be supported by standard galvanized bar supports, bar supports with plastic tips, stainless steel bar supports, approved plastic bar supports or approved pre-cast mortar or concrete blocks,

Mortar or concrete blocks shall be cast to uniform dimensions with adequate bearing area. A suitable tie wire shall be provided in each block for anchoring to the steel. They shall be accurately cast to the thickness required in molds approved by the Engineer. The surface placed adjacent to the form shall be a true plane, free of surface imperfections. The blocks shall be cured by covering with wet burlap or mats for a period of 72 hours. Mortar for blocks shall contain approximately 1 part cement to 3 parts sand. Concrete for blocks shall contain 9 sacks of cement per cubic yards.

Individual bar supports shall be placed in rows at 4 foot maximum spacing in each direction. Continuous type bar supports shall be placed at 4 feet maximum spacing.

Reinforcing steel for bridge slabs, top slabs of culverts and the top slabs of pre-stressed box beams shall be tied at all intersections except that where the spacing is less than 1 foot in each direction, alternate intersections only need to be tied. For reinforcing steel cages for other structural members, the steel shall be tied at enough intersections to provide a rigid cage of steel. Mats of wire fabric shall overlap each other 1 full space as a minimum to maintain a uniform strength and shall be fastened securely at the ends and edges.

Before any concrete is placed, all mortar, mud, dirt, etc. shall be cleaned from the reinforcement. No concrete shall be deposited until the Project Representative approves reinforcing steel placement.

If the reinforcement is not adequately supported or tied to resist settlement, floating upward, overturning of truss bars, or movement in any direction during concrete placement, permission to continue concrete placement will be withheld until corrective measures are taken. Sufficient measurements shall be made during concrete placement to insure compliance.

III. Equipment: (not used)

IV. Construction Methods: (not used)

V. Measurement and Payment: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be considered subsidiary to pertinent Subsections.

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