

ITEM 440

REINFORCING STEEL

440.1 Description. This item shall govern for the furnishing and placing of reinforcing steel of the type, size and quantity designated for use in structures, as shown on the plans and in accordance with these specifications.

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

- A. ASTM Designation A615, Grade 40 or 60, open hearth, basic oxygen or electric furnace new billet steel.

Unless noted by these specifications, rail steel or axle steel shall not be permitted.

When no specific grade is specified on the plans, the reinforcing steel shall be a minimum Grade 60.

Where bending of bar sizes #14 or #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 degrees around a pin having a diameter of 10 times the nominal diameter of the bar.

- B. Spiral reinforcement shall be either smooth or deformed bars, or wire, of the minimum size or gage shown on the plans or as specified herein. Bars for spiral reinforcement shall comply with ASTM Designation A675, A615 or A617. Wire shall conform to ASTM Designation A82.

Unless otherwise shown on the plans, the minimum yield strength for spiral reinforcement shall be 40,000 psi.

Report of chemical analysis, showing the percentages of carbon, manganese, phosphorus and sulphur will be required of all reinforcing steel bars when it is to be welded.

The nominal size and area and the theoretical weight of reinforcing steel bars covered by this specifications are as follows:

Table No. 1

Bar Size #	Nominal Diameter In.	Nominal Area Square Inch	Weight per Linear Foot
2	0.250	0.05	0.167
3	0.375	0.11	0.376
4	0.500	0.20	0.668
5	0.625	0.31	1.043
6	0.750	0.44	1.502

7	0.875	0.60	2.044
8	1.000	0.79	2.670
9	1.128	1.00	3.400
10	1.270	1.27	4.303
11	1.410	1.56	5.313
14	1.693	2.25	7.65
18	2.257	4.00	13.60

- C. When wire is ordered by size numbers, the following relation between size number, diameter in inches and area shall apply unless otherwise specified.

Table No. 2

Size #	Nominal Diameter Inch	Nominal Area Square Inch
31	0.628	0.310
30	0.618	0.300
28	0.597	0.280
26	0.575	0.260
24	0.553	0.240
22	0.529	0.220
20	0.505	0.200
18	0.479	0.180
16	0.451	0.160
14	0.422	0.140
12	0.391	0.120
10	0.357	0.100
8	0.319	0.080
7	0.299	0.070
6	0.276	0.060
5.5	0.265	0.055
5	0.252	0.050
4.5	0.239	0.045
4	0.226	0.040

Size #	Nominal Diameter Inch	Nominal Area Square Inch
3.5	0.211	0.035
3	0.195	0.030
2.5	0.178	0.025
2	0.160	0.020
1.5	0.138	0.015
1.2	0.124	0.012
1	0.113	0.010
0.5	0.080	0.005

Where deformed wire is required the size number shall be preceded by D, and for smooth wire, the prefix W will be shown.

D. Where plain steel wire is used for concrete reinforcement, it shall meet the requirements of ASTM A82.

Fabricated deformed steel bar mats shall meet the requirements of ASTM A184, while plain steel welded wire fabric shall meet the requirements of ASTM A185.

Deformed steel wire for concrete reinforcement shall meet the requirements of ASTM 496, while deformed steel welded wire fabric shall meet the requirements of ASTM 497.

440.3 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 on the plans, bends shall be made in accordance with ACI 315.

Bends of 90° and greater in stirrups, ties and other secondary bars that enclose another bar in the bend, in terms of the nominal bar diameter (d), shall be as follows:

Table No. 3

	Grade 40	Grade 60
#3, #4, #5	4d	4d
#6, #7, #8	6d	6d

All bends in main bars and in secondary bars not covered above shall be as follows:

Table No. 4

	Grade 40	Grade 60
#3 through #8	6d	6d
#9, #10, #11	8d	8d
#14, #18	10d	10d

440.4 Fabricating Tolerances. Fabricating tolerances for bars shall be as indicated in ACI 315.

440.5 Storing. Steel reinforcement shall be stored above the surface of the ground upon platforms, skids or other supports and shall be protected 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 proportions of a hand wire brushed specimen meets the physical requirements for the size and grade of steel specified.

440.6 Lap Splices. Splicing of bars, except where shown on the plans, will not be permitted without prior 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 subject to the following:

Splices will 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 one splice length, with no more than one individual bar length less than 10 feet. Splices not shown on the plans, but permitted hereby, shall be made in accordance with Table No. 5. The specified concrete cover shall be maintained at such splices and bars placed in contact and securely tied together. Lap bars so that both bars will be in the same plane parallel to the nearest concrete surface.

Table No. 5

Minimum Lap Requirements

Size #	Grade 40	Grade 60
3	1' - 0"	1' - 0"
4	1' - 2"	1' - 9"
5	1' - 5"	2' - 2"
6	1' - 9"	2' - 7"
7	2' - 4"	3' - 5"
8	3' - 0"	4' - 6"
9	3' - 10"	5' - 8"
10	4' - 10"	7' - 3"
11	5' - 11"	8' - 11"

Spiral steel will be lapped a minimum of one turn.

Sizes #14 and #18 may not be lapped.

440.7 Welded Splices. Where shown on the plans or required by the provisions of this item or other pertinent specifications, welded bar splices shall be used. All welding operations, processes, equipment, materials, workmanship and inspection shall conform to the American Welding Society Specification D1.4. For bars #6 and smaller, use lap weld splices with fillet welds equal to one half bar diameter on each side, for 4 inches in length. For bars #7 and larger, use butt weld splices in accordance with AWS D1.4.

All splices whether lap, weld, mechanical or coupler, shall develop the full strength of the bar. Information on mechanical splicing devices and couplers shall be submitted for approval prior to use.

440.8 Placing. Steel reinforcement shall be placed in the exact position as shown on the plans and held securely in place during the placing of the concrete. The dimensions shown are to centers of bars, unless otherwise noted. Hold bars securely in place with wire and other approved means during placement of concrete.

- A. In plane of steel parallel to nearest surface of concrete, bars should not vary from plan spacing by more than one twelfth of spacing between bars.
- B. In plane of steel perpendicular to nearest surface of concrete, bars shall not vary from plan placement by more than 1/4 inch.

Space steel the required distance from forms or earth by approved galvanized metal spacers, metal spacers with plastic coated tips, stainless steel spacers, plastic spacers, or approved precast mortar or concrete blocks. For approval of plastic spacers, provide samples of plastic which show no indications of deterioration after immersion in a 5percent solution of sodium hydroxide after 120 hours.

Use galvanized metal chairs to support all reinforcing steel, except that pavement steel chairs need not be galvanized. Use a heavy bolster to support bottom layer of reinforcing in abutment caps, bent caps and other beams.

In bridge deck slabs, use two rows of supports for bottom layer of reinforcing parallel to beams for each bay. Use high chairs to support top layer.

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

Before any concrete is placed, all mortar, mud, dirt, etc., shall be cleaned from reinforcement. No concrete shall be deposited, until the Engineer has inspected the placement of the reinforcing steel and given permission to proceed.

440.9 Submittals. The following information shall be submitted for reinforcing steel. Six sets of each item shall be submitted.

- A. Product data for all materials used.
- B. Shop drawings indicating locations, placement, sizes, and bending.

- C. Shop drawings shall be in accordance with the ACI Manual of Practice for Detailing Reinforced Concrete Structures.
- D. When welding is required, furnish report of chemical analysis, showing percentages of carbon, manganese, phosphorus and sulfur.
- E. Submit certified copies of mill certificates of compliance with requirements herein specified.
- F. Submit information on mechanical splicing devices, couplers, and all other reinforcing accessories.

440.10 Measurement & Payment. Reinforcing steel quantities will not be measured or paid for directly. All costs of furnishing, fabrication, placement, ties, chairs, bending, labor and equipment shall be considered subsidiary to bids for concrete structures and pavements, requiring reinforcement.

END OF ITEM 440