

**415 REINFORCING STEEL.**  
**(REV 12-10-04) (FA 1-3-05) (7-05)**

SECTION 415 (Pages 378-384) is deleted and the following substituted:

**SECTION 415**  
**REINFORCING STEEL**

**415-1 Description.**

Furnish and place in concrete masonry reinforcing steel of the quality, type, size, and quantity designated.

**415-2 Materials.**

Meet the following requirements:

Bar Reinforcement .....	931-1.1
Fabric Reinforcement.....	931-1.2

**415-3 Protection of Material.**

Store steel reinforcement above the surface of the ground, upon platforms, skids, or other supports, and protect it as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placing steel reinforcement in the work, ensure that the steel reinforcement is free from loose rust, scale, dirt, paint, oil, and other foreign material.

**415-4 Bending, Splicing, and Cutting.**

Fabricate reinforcing bars as prescribed in the CRSI Manual of Standard Practice. Bend the reinforcement cold to the shapes indicated in the plans. Perform bending in the shop before shipment, and not in the field unless shown otherwise in the Contract Documents.

Do not hot bend or straighten, weld, or thermal cut reinforcing steel unless otherwise specified in the Contract Documents.

**415-5 Placing and Fastening.**

**415-5.1 Bar Spacing - General:** Except as otherwise specified herein, ensure that each bar is within 1 inch [25 mm] of the plan position.

**415-5.2 Concrete Blocks for Spacing:** Use precast concrete blocks to space and support the reinforcing steel. Use concrete blocks with a strength equal to or greater than the concrete in which they are to be placed and have wires cast into them for fastening to the steel. Moist-cure the blocks for at least three days.

Provide a letter stating the class of concrete used to fabricate the concrete blocks, and identifying the batch and load of concrete from which the concrete blocks were cast.

**415-5.3 Wire for Tying:** For tying reinforcing steel, use soft pliable wire, that readily bends and twists without breaking and that provides a tie of sufficient strength to hold the reinforcing steel in its proper position.

**415-5.4 Splices:** Where splices are authorized, rigidly clamp the bars or tie them in a manner meeting the Engineer's approval. Use the splice length as shown on the plans. The

Contractor may submit additional splices the Specialty Engineer recommends for approval prior to use.

Do not use welded splices except as specifically authorized by the Engineer and, when authorized, meet the requirements of AWS D 1.4 “Structural Welding Code - Reinforcing Steel”.

Use mechanical couplers or splice devices which develop at least 125% of the specified yield strength of the bar being spliced and are listed on the Departments Qualified Products List.

#### **415-5.5 Footings:**

**415-5.5.1 Supports:** In general, support the footing mat steel with mortar blocks having dimensions not greater than 4 by 4 inches [100 by 100 mm] by plan clearance. Fasten mortar blocks to the steel using the cast-in wires. The Engineer may approve other proposed means of support.

**415-5.5.2 Tolerances:** Place footing mat steel within 1/2 inch [13 mm] vertically from the plan bottom clearance and within 1 inch [25 mm] from the plan side clearance.

**415-5.5.3 Tying:** Tie footing mat steel with a double-strand single tie at all intersections on the periphery and at alternate intersections within the mat.

#### **415-5.6 Dowel Bars for Columns and Walls:**

**415-5.6.1 Supports and Positioning:** Position dowel bars projecting into columns and walls so as to allow splicing of the column bars or vertical wall bars to the dowels and to tie the dowel bars in their plan position. Support the dowel bars by a rigid template constructed across the top of the footing, and attach them to the template in such manner that placing the concrete does not disturb their position. Set the supports prior to the pouring of the concrete in the footings, and do not push dowel bars into the wet concrete after placing the footing concrete.

**415-5.6.2 Tolerances:** Place the dowels within 1/2 inch [13 mm] of their plan position and with a side clearance tolerance not exceeding 1/4 inch [6 mm].

#### **415-5.7 Verticals and Hoops for Columns:**

**415-5.7.1 Spacing-off from Side Forms:** Space-off column steel from the side forms by mortar blocks of dimensions not exceeding 2 by 2 inches [50 by 50 mm] by clearance dimension. Securely fasten each block to the reinforcing.

##### **415-5.7.2 Tolerances and Clearance:**

(a) Column Verticals: Place column verticals within 1/2 inch [13 mm] of their plan position. Ensure that the side form clearance is within 1/4 inch [6 mm] of the specified clearance.

(b) Column Hoops: Place every hoop within 1 inch [25 mm] of the plan position for the specific hoop, with no accumulation of such tolerance caused by the spacing between any two hoops. Ensure that side form clearance for any hoop is within 1/2 inch [13 mm] of its specified clearance.

**415-5.7.3 Tying:** Tie the column hoops to the column verticals at each intersection, by a cross tie or “figure 8” tie.

#### **415-5.8 Wall Steel (Not Including Dowel Bars):**

**415-5.8.1 Supports:** Space-off wall steel from the side forms by mortar blocks of dimensions not greater than 2 by 2 inches [50 by 50 mm] by clearance dimensions. Fix the spacing between wall mats by means satisfactory to the Engineer.

**415-5.8.2 Tolerance:** Except where it is necessary in order to clear a fixture, place each bar within 1 inch [25 mm] of its specified position. In any case, ensure that the number of bars in any affected unit is as specified, and place the remainder of the bars (not thus affected) within the specified 1 inch [25 mm] tolerance.

**415-5.8.3 Tying:** Tie wall steel with a cross tie or “figure 8” tie. On the periphery, tie the steel at each intersection. Within the mat, tie the steel at every third intersection, except that where the wall is of such size that it is necessary that workmen use the reinforcing as a ladder, the Engineer may require tying at every other intersection, or at every intersection, as he deems necessary.

#### **415-5.9 Beams and Caps:**

**415-5.9.1 Supports:** Maintain bottom clearances by approved heavy beam bolsters. Support additional layers of main longitudinal steel from the lower layers by heavy upper-beam bolsters, placed directly over low supports.

Begin the spacing of beam bolsters at not more than 2 feet [0.6 m] from the end of the beams or caps and space the additionally required bolsters at not more than 4 feet [1.2 m].

Use mortar blocks, having dimensions not greater than 2 by 2 inches [50 by 50 mm] by specified clearance, fastened to the steel by the cast-in wires, for spacing the upper main longitudinal steel below the top bars. Maintain the side clearance by mortar blocks, having dimensions not greater than 2 by 2 inches [50 by 50 mm] by required clearance, fastened to the reinforcing steel by the cast-in wires.

**415-5.9.2 Tolerances:** Place the main longitudinal steel so as to provide a bottom and top clearance within 1/4 inch [6 mm] of the plan vertical dimensions for all layers. Space the steel from side forms within 1/2 inch [13 mm] of the specified spacing.

Space and tie the stirrups within 1 inch [25 mm] of the plan position for each individual stirrup, and do not allow the tolerance to accumulate.

**415-5.9.3 Tying:** Tie all intersecting bars with a double-strand single tie.

#### **415-5.10 Deck Slabs:**

##### **415-5.10.1 Supports:**

(a) Bottom Mats: In general, support the bottom mats of steel by one row of slab bolsters placed 6 inches [150 mm] from the edge of the slab and by two rows down each panel between beams. Do not allow the spacing between rows to exceed 4 feet [1.2 m], measured center to center.

As an exception, when deemed satisfactory by the Engineer, the Contractor may use mortar blocks in lieu of slab bolsters. Use blocks 2 by 2 inches [50 by 50 mm] by clearance dimensions. Space mortar blocks 4 feet [1.2 m] on center as a maximum. If at any time, however, the Engineer judges that the mortar blocks do not provide the proper support, he may require using slab bolsters.

(b) Top Mats: Support the top mats of steel by either continuous high chairs or individual high chairs. Support continuous high chairs along both sides of each beam and approximately 6 inches [150 mm] back from the edge of the beam. Place the outside row of high chairs 6 inches [150 mm] from the edge of the slab. If using individual high chairs, space them transversely, as specified for the continuous high chair, and do not allow the longitudinal spacing to be greater than 4 feet [1.2 m].

As an alternate to the above, on prestress beam construction, the Contractor may support the top mat of steel on the shear connectors bent to the proper elevation with one line of high chairs centered between the beams.

(c) Truss Bars: Support truss bars at each end of the top bends by continuous high chairs or by individual high chairs spaced longitudinally at not more than 4 feet [1.2 m].

**415-5.10.2 Tolerances:** Ensure that top and bottom clearances are within 1/4 inch [6 mm] from those shown on the plans.

Ensure that end and bottom clearances are within 1/4 inch [6 mm] from those shown on the plans.

Ensure that end and edge clearances are within 1/4 inch [6 mm] of the clearance specified.

Place curb bars within 1/4 inch [6 mm] in any direction of the plan position.

**415-5.10.3 Tying:** Tie all steel in each layer with a double-strand single tie at every intersection on the periphery and at every third intersection in the interior area. If encountering difficulty in maintaining the reinforcing steel in position during the placing of concrete, tie additional intersections as necessary to hold the reinforcing steel secure.

#### **415-5.11 Box Culverts:**

##### **415-5.11.1 Supports:**

(a) Bottom Slabs: In the bottom slabs of box culverts, provide supports for single-mat steel and for bottom-mat steel, including placement and spacing, as specified for footing mat steel in 415-5.5. In addition, where the plans call for more than one mat of steel in the bottom slab of the culvert, support the top mat away from the bottom mat, either by upper beam bolsters or by other means satisfactory to the Engineer.

(b) Walls: Place, space and support the steel in walls of box culverts in accordance with the requirements of 415-5.8.

(c) Top Slabs: In the top slabs of box culverts, support the bottom mats of steel by a row of slab bolsters 12 inches [300 mm] from the inside face of the walls and with additional rows of bolsters at spacings not exceeding 4 feet [1.2 m], center to center. As an exception, unless the Engineer deems the use of the slab bolsters as necessary to obtain proper support, the Contractor may use mortar blocks as the supporting device. Use blocks of dimensions not greater than 2 by 2 inches [50 by 50 mm] by the required clearance, with spacings not exceeding 4 feet [1.2 m] in any direction. Fasten blocks to the reinforcing steel by the cast-in wires.

(d) Truss Bars: Support truss bars as specified in 415-5.10.1 (c).

**415-5.11.2 Tolerances:** Use tolerances in placing the steel in box culvert slabs as specified for deck slabs in 415-5.10.2. Use tolerances for placing steel in walls as specified in 415-5.8.2.

**415-5.11.3 Tying:** Tie steel in box culverts as specified for deck slabs in 415-5.10.3.

**415-5.12 Cleaning:** Before placing any concrete, clean all mortar from the reinforcement.

##### **415-5.13 Chairs and Bolsters:**

**415-5.13.1 General:** Provide reinforcing steel bar supports manufactured in accordance with all requirements of the CRSI Manual of Standard Practice. Use chairs and

bolsters of adequate strength to withstand a 300 pound [1.3 kN] concentrated load without permanent deformation or breakage, with the deformation under a 300 pound [1.3 kN] load being less than 5% of the support height.

Ensure that no more than 5% of the reinforcing steel bar supports exhibit unsatisfactory performance, breakage, or permanent deformation during rebar tying and/or concrete placement operations. If a bar support does not achieve this level of performance, reduce the average spacing between bar supports by 15%, or remove that product from use on the job.

Ensure that bar supports, both chair and bolster, do not move during concrete placing operations. To prevent movement, tie supports to the reinforcing steel.

When using bar supports on corrugated metal stay-in-place forms, use supports specifically designed for the form being used.

**415-5.13.2 Metal Chairs and Bolsters:** Do not use metal chairs and bolsters for substructures in extremely aggressive environments. For metal bar supports in contact with steel stay-in-place forms and metal bar supports in contact with boundary surfaces of concrete to be cast, provide supports constructed with molded plastic legs or plastic protected steel legs. Do not allow any portion of the bar support other than the molded plastic leg or plastic protected portion of the steel leg to be closer than 1/2 inch [13 mm] from the boundary surface of concrete to be cast.

Certify that all metal bar supports meet the following requirements:

(1) That they are manufactured from cold drawn steel wire in accordance with the wire sizes and geometrical dimensions shown in the CRSI Manual of Standard Practice, Chapter 3, Table II.

(2) That the plastic used for protection of the steel legs has a thickness of 3/32 inch [2.5 mm] or greater at points of contact with the form work.

Provide plastic protection by a dipping operation, by adding premolded plastic tips to the legs of the support or by molding plastic to the top wire of the support. Ensure that the plastic material used for protection of steel legs does not chip, crack, deform, or peel under ordinary job conditions. Provide molded plastic legs that have sufficient strength to carry the weight of the supported reinforcing steel in its required position without deformation and relaxation under job conditions.

**415-5.13.3 Plastic Chairs and Bolsters:** Use chairs and bolsters comprised of either reinforced or non-reinforced virgin or recycled plastic, able to meet the concentrated load requirements of 415-5.13.1 within a working temperature range of 20 to 150°F [-7 to 65°C], and have a maximum water absorption rate of 0.5%, as per ASTM D 570.

Protect plastic rebar chairs from exposure to sunlight until placed in the form. Mold plastic rebar supports in a configuration which does not restrict concrete flow and consolidation around and under the rebar support. Do not use continuous legs or rails on concrete surfaces.

Due to the wide range of applications and heights, ensure that the manufacturer additionally certifies all plastic chair and/or bolster systems for 2 inch, 3 inch, 4 inch and 4 1/2 inch [50 mm, 75 mm, 100 mm and 113 mm] heights.

Provide each individual bar support with an identification number unique to the particular model permanently marked on the surface as included in the Qualified Products List.

**415-5.13.4 Qualified Products List:** Use plastic chair and bolster products listed on the Department's Qualified Products List. Manufacturers seeking evaluation of products for inclusion on the Qualified Products List must submit an application in accordance with 6-1 and include certified test reports from an independent laboratory showing that the plastic chair and bolster products meet all the requirements specified herein.

#### **415-6 Welded Deformed Steel Wire Fabric Reinforcement.**

**415-6.1 General:** The Contractor may substitute welded deformed steel wire fabric reinforcement for deformed bar reinforcement when approved on shop drawings. Propose substitutions of welded deformed steel wire fabric in a manner that provides a cross-sectional area per foot [meter] of welded deformed steel wire fabric equal to that provided on the plans for deformed bar reinforcement. Orient the deformed wires of welded deformed steel wire fabric reinforcement in the same position as bar reinforcement detailed in the plans. The Contractor may use smooth or deformed cross wires of welded deformed steel wire reinforcement. Use a cross wire size that is a minimum of 35% or more of the area of the deformed wire.

Provide welded steel wire fabric reinforcement as shown in the plans.

**415-6.2 Design:** When welded deformed steel wire fabric reinforcement is substituted for deformed bar reinforcement, ensure that the development length, splices, shear reinforcement, and distribution meet the requirements of the AASHTO Standard Specifications for Highway Bridges.

#### **415-7 Method of Measurement.**

**415-7.1 General:** The quantity to be paid for will be the computed weight, in pounds [kilograms], of reinforcing steel entering into the completed structure or item of work and accepted. The quantity will not include the reinforcing steel in any item of work for which the basis of payment includes the steel reinforcement. No separate payment will be made for reinforcing steel in pipe endwalls. No deduction will be made from reinforcing steel quantities for encroachment of inlets and pipes in box culverts. The lengths to be used in the calculation will be the detailed lengths of bars as shown in the plans. The quantity to be paid for will be the original plan quantity, determined as provided above.

**415-7.2 Unit Weights of Bars:** The unit weights used will be CRSI Standard Reinforcing Steel Bar Weights.

**415-7.3 Fabric Reinforcement:** Where fabric reinforcement is to be paid for by weight, the quantity to be paid for will be the product of the area, in square feet [square meters], of the fabric actually incorporated in the structure and accepted, by the manufacturer's standard weight per square foot [square meter].

When welded deformed steel wire fabric reinforcement is substituted for deformed bar reinforcement, the quantity to be paid for will be the quantity which would be paid for if bar reinforcement as detailed in the plans were utilized, based on plan quantity.

#### **415-8 Basis of Payment.**

Price and payment will be full compensation for all work specified in this Section, including all welding, all clips, spacers, ties, mechanical couplers, etc., and wire or other material used for fastening the reinforcement in place.

In case short bars are permitted for use when full length bars might reasonably be required, the weight paid for will be only that which would be obtained if full length bars were used, with no allowance for lap.

Payment will be made under:

Item No. 415- 1- Reinforcing Steel - per pound.

Item No. 2415- 1- Reinforcing Steel - per kilogram.