

■ Chapter 3: Reinforcing Steel

Reinforcing steel (rebar, reinforcing bar, or reinforcing) as used in reinforced concrete structures, is strength-graded steel that has been manufactured with deformations to provide tension capacity of the concrete element.

- Section 3-1 below details industry standards and resources for rebar use and fabrication.
- Section 3-2 describes mandatory inspection standards, including proper placement, clearances, and rebar modification such as splicing, blocking, and tying.

3-1 General Specification Review for Bridge Deck Reinforcement

All reinforcement for bridges must conform to specifications of the American Society for Testing and Materials (ASTM) A 706/A 706M.¹ ASTM A 615/A 615M Grade 40 or 60 are still allowed for use in some applications. Welded wire fabric may be used in certain circumstances, but must be on an equivalent area basis. If plans show that the deck reinforcing has an epoxy coating-1.0, then all Standard Specifications (SS) 52-2, *Epoxy-Coated Reinforcement and Epoxy-Coated Prefabricated Reinforcement*, requirements must be met.

3-1.1 Standard Details

Standard Details are found in the Standard Plans. The *Index to Plans* sheet of the structure contract plans usually lists the standard plans used. Following are examples of commonly used standard details. Standard Plan Detail BO-5, lists transverse and longitudinal reinforcing spacing requirements, location of deck construction joints, and deck reinforcing placement notes. If there are access openings in the deck, check B7-11 for reinforcing details. Review the plans to ensure that access openings are not in wheel lines. If there is a conflict, discuss it with the Structure Designer. For placement of deck drains, check plans B7-5 through 8. Concrete Barrier details are found in Plans B11-54 through B11-70.

Other information, such as hook and bend length, and radius, are in the *Bridge Construction Records and Procedures Manual (BCR&P)*, Volume 2, Section 165, *Reinforcing Steel*. The details conform to American Concrete Institute (ACI) code requirements for hooks and bends. ACI code (*BCM 165-1.0*) governs unless different lengths are shown on the plans.

¹ 2010 SS 52-1.02B, *Bar Reinforcement*.

3-1.2 Detailing and Fabrication

Deck contours (4-scales) should be made available to the Reinforcing Steel Fabricator to reduce the probability of detailing errors. Special details for deck reinforcing and change orders affecting reinforcement should be brought to the Contractor's attention.

Errors in detailing or fabrication are more likely to occur on bridges with the following characteristics:

- Varying girder spacing.
- Varying deck thickness.
- Large skew.
- Varying skew.
- Wide, curved bridges with small curvature radius.
- Future widening.

Fabrication is seldom a problem unless the standard industry practices for fabrication dimensions, as shown in BCR&P, BCM 165, *Reinforcing Steel*, are ignored.

3-2 Inspection

On bridges with the characteristics listed in 3-1.2, watch for incorrect reinforcing in the corners, truss bars not centered over the girders, incorrect bar termination location, omission of bars at the overhangs and at the bent cap, etc. Also common is omission of reinforcement shown on the Standard Details, especially around barrier rail-mounted utilities. The best time to inspect truss bars for length and depth is prior to placement.

During field inspection of the reinforcing steel, check the markings on the bars. The markings signify the bar size, grade, and steel mill. A complete guide to reading the bar markings is BCM 165-2.0, *Identification of Reinforcing Steel Bars*, of the Bridge Construction Records and Procedures Manual.

Carefully confirming that all deck reinforcing and clearances meet contract plans and Standard Specification requirements improves safety and reduces future repair costs. Following are some specific materials and procedures to include during inspections.

3-2.1 Placement

Reinforcing must be placed as shown in the contract plans, the Standard Plans, or any applicable change orders. A significant amount of current bridge maintenance funds are spent on deck rehabilitation projects. It is important for deck reinforcement and clearances to match plans to reduce future deck rehabilitation costs.

Correct placement is covered in the Standard Specifications². For specific practices and

² 2010 SS 52-1.03(D), *Placing*.

standards not covered in the Standard Specifications, check with the Designer to determine the tolerances or variations in placement that are allowed.

Periodic and timely inspections are strongly recommended during bar placement for early detection and correction of errors. Proactive inspection prior to placement can save the project time and money. Timely inspection minimizes re-work costs and results in a better product.

3-2.2 Clearances

Correctly placed deck reinforcement that provides the planned clearance or cover for the bars is extremely important. Too little cover will not adequately protect reinforcing from water and chloride intrusion resulting in rusting that can dramatically shorten the life of the deck. This is especially true in a marine environment or where de-icing chemicals are used. Concrete spalling on the deck or edge of the deck can occur from corroding reinforcing bars with inadequate cover; this creates unsightly stains and costly maintenance.

Always inspect the clearance to the top deck, the minimum clearance at the boundaries, and the reinforcing bar ends to make sure they match the typical section in the contract plans. In marine environments or in areas where de-icing chemicals are used, cover may be increased. In addition, on segmental bridges or bridge decks constructed under the *quiet deck* specification, there most likely will be thicker deck coverage. This thicker cover allows for texture grinding later on to provide a final grooved, quiet riding surface.

3-2.3 Splices

Lap splicing is the most common method of splicing deck bars.³ The minimum lap splice length for ASTM A 706/A 706M rebar is 45 bar diameters for rebar sizes #8 or smaller and 60 bar diameters for #9 thru #11 rebar. Unless otherwise shown on the plans, the splices in adjacent bars must be staggered. The minimum distance between the staggered splices must be the same as the length required for a lap splice in the largest bar. During inspection, make sure the splices are securely tied and will not move during the deck pour. Additional longitudinal mild steel reinforcement that is continuous over the bent caps must be continuous or spliced using ultimate butt splices.

For widenings and closure pours, reinforcing splices may be welded or mechanically spliced.⁴ A list of approved couplers for service splice qualifications or ultimate butt splice qualifications may be found in the Authorized List of Couplers for Reinforcing Steel.⁵

³ 2010 SS 52-6.03B, *Lap Splicing*.

⁴ 2010 SS 52-6.03C, *Service Splices and Ultimate Butt Splices* and BCM 165-7.0, *Qualification of Bar Reinforcement Splices*, for the correct procedures to follow for welded or mechanically spliced reinforcing.

⁵ http://www.dot.ca.gov/hq/esc/approved_products_list/pdf/steel_reinforcing_couplers.pdf

3-2.4 Blocking and Tying

All deck reinforcing must be securely tied and blocked up off the deck to prevent any movement during placement of the deck concrete. The use of wooden, plastic, or aluminum supports is not permitted.⁶ If ferrous metal chairs are used, they must have at least one inch of cover. The plastic coatings on the chair feet are not considered to be effective cover. The Specifications also do not permit placing reinforcing bar into wet concrete during the pour. Precast mortar blocks (dobies) are used to assure attainment of the required concrete cover on the bottom rebar and for ferrous chairs (Figure 3.2-1).



Figure 3.2-1. Precast Mortar Blocks Under the Bottom Rebar Mat.

Between the girders, “ducked” or buried bars are shown on the plans to support the bottom mat. Typically, they are #4 bars spaced at about two feet on center. Truss bars and precast mortar blocks support the top mat. Truss bars must be securely tied to prevent any rotation. Truss bars, as shown in Figure 3.2-2, must not be allowed to rotate out of vertical position. If they rotate, the top mat will be out of position and result in reduced deck strength. If truss bars are not used, the contractor will use precast mortar spacer blocks to support the top mat. At or near the girders, some contractors will attempt to support the top deck mat on the stirrup tails. This can be an effective method of support, provided that the tails are correctly positioned to do this task and the bars are securely tied to the tails to prevent movement before or during the pour.

⁶ 2010 SS 52-1.03D, *Placing*.



Figure 3.2-2. Truss Bars Must Not be Allowed to Rotate out of Vertical.

Mats of reinforcing steel must be tied firmly and securely in position during the pour. This is accomplished by wiring at intersections and splices. ACI recommends that bars be tied at every other intersection and this may be adequate in most cases. More frequent tying may be necessary at corners, over bent caps, and other special locations.⁷

⁷2010 SS Section 52-1.03D, *Placing*.