PCI Plant Quality Talk
Quality Enhancement Committee

SERIES 3, ISSUE 6 – REINFORCEMENT

Concrete is strong in compression but less so in tension. Steel exhibits strength in tension. When these materials are used together strategically, they complement each other, resulting in a very strong construction material: reinforced concrete. During the manufacturing process care must be taken throughout material procurement, storage, and fabrication to optimize the benefits of concrete and steel together. The bond between reinforcement and the surrounding concrete is critical to a precast concrete component's performance.

Storage

- Regardless of the type of reinforcement, the time of year, or the storage location, all reinforcement should be stored elevated from the ground. When reinforcement contacts the ground, contaminants such as dust, dirt, and oil can cling to the reinforcement's surface and reduce its ability to bond with concrete.
- Limiting the exposure of reinforcement to moisture will reduce the amount of rust that will develop on the reinforcement prior to its use.
- Some reinforcement may be shipped from the supplier with minor spots of rust. Rough steel surfaces can enhance the bond with concrete, so minor amounts of rust can improve bond strength. However, reinforcement must not be used if it shows signs that rusting has reduced the reinforcement's cross-sectional area.
- All reinforcement materials—whether bundles, mats or coils—must always be easily identifiable for as long as you have the material. The mill identification tag affixed to the shipment, which shows the supplier name, steel grade, dimensions and/or bar size, heat number, and other information, must remain attached to the supply until the supply is completely used.
- Stored reinforcement should be protected when in proximity to welding operations. Welding sparks can cause damage and create weak spots that may lead to failure.
- For information about the handling of epoxy-coated reinforcement, see Q*uality Talk Series 1, Issue 8: Handling Epoxy-Coated Reinforcing Bars*.

Fabrication

- Proper bending and handling of reinforcement during fabrication is needed to ensure that the reinforcement placed in the precast component will provide the necessary strength, constructability, and durability during its use. Bend diameters and hook lengths are carefully considered in the design and detailing of the precast component.
- All reinforcement must be fabricated in accordance with detailed production and fabrication drawings. ACI 117, *Specification for Tolerances for Concrete Construction and Materials*, outlines reinforcement fabrication tolerances. However, some projects or jurisdictions will specify different tolerances, so it is imperative that the project documents clearly indicate the governing tolerance requirements.
- Use care when measuring, cutting, and bending reinforcement to ensure accuracy.
- Bending reinforcement in extremely cold weather without preheating of the bars may cause cracking or brittle breakage.
- Using reinforcement templates or jigs for frequently used or standard designs can help expedite the reinforcement cutting, layout, and assembly process while also reducing possibilities for human error.

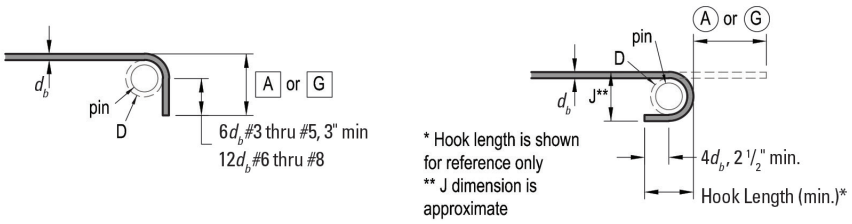


Figure 1. Concrete Reinforcing Steel Institute's standard hook and bend details in accordance with ACI 318.

- When bending reinforcing bars, benders in the field or fabricators in the shop must exercise caution to ensure that the bends are not too sharp (with the proper radius for the reinforcing bar size). Reinforcing bars may crack or weaken if bent too sharply.
- All reinforcement should be bent in accordance with standard Concrete Reinforcing Steel Institute (CRSI) fabrication practices unless the project specifications require compliance with different requirements, such as AASHTO. Give special attention to the minimum bend diameters and hook dimensions associated with different bar sizes, lengths, and steel types, which are set forth by CRSI and reference ACI 318.
- If the design, project specifications, or detailed reinforcing plans require a bend in reinforcing around a corner, it is not acceptable to substitute straight sections tied or welded together.
- Reinforcement cages, bar mats, and other configurations must be fabricated into rigid assemblies so they will retain their shape, dimensions, spacing, and integrity during handling, transport, positioning in the form, and concrete placement.
- Reinforcement should only be welded where shown on the fabrication and production drawings in accordance with approved plant welding procedures and AWS D1.4, *Structural Welding Code-Reinforcing Steel*.
  - Reinforcement that complies with ASTM A615, Standard *Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement*, is usually not weldable direct from the supplier. Prior to welding, carbon equivalence calculations must be performed to determine any preheating requirements. If the carbon equivalent falls outside of the target range, the bars must be preheated before welding as determined by the carbon equivalence calculation.
  - Reinforcement that complies with ASTM A706, *Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement*, is a low-carbon reinforcement. It is generally considered weldable without performing carbon equivalent calculations as long as the material temperature is above freezing.
  - When the reinforcement is below 32°F (0°C), AWS D1.4 requires low-carbon reinforcement to be preheated to at least 70°F (20°C), with that minimum temperature maintained during the welding process.
  - When welding any type of reinforcement, be careful not to burn through the reinforcement or cause undercutting; these actions compromise the reinforcement and weld integrity.
- Lap splices allow two lengths of reinforcement or two ends of welded wire reinforcement to be joined to act as one continuous section of reinforcement. Minimum lap splice lengths are dictated by ACI 318 or AASHTO and depend on the concrete strength, steel grade, and reinforcement bar size and spacing.

Additional Resources from CRSI

- CRSI RB4.1, *Supports for Reinforcement Used in Concrete* (2016)
- CTN-M-2-11 *Field Guide for Rust on Reinforcing Bars*
- ETN-M-5-14: *Rust, Mill Scale, and Other Surface Contaminants on Steel Reinforcing Bars*
- *Placing Reinforcing Bars*, 10th ed. (2019)

PCI Plant Quality Talk
Quality Enhancement Committee

Note: Please complete this form and return to the Quality Control Manager. All crew members should be observant and report to their foreman anything out of the ordinary on a project. See something, say something.

NOTES	ATTENDEE SIGNATURES
DATE PRESENTER	