

Corner Details for Wall Horizontal Bars

Continuity of horizontal reinforcing steel at corners and wall intersections can be ensured in several ways. While the designer's first concern must be to provide connections that satisfy safety and serviceability requirements, the designer must also be aware that some reinforcement details may be more constructible than others.

ISSUES

In general, long horizontal reinforcing bars with hooks at one or both ends should be avoided. For the ironworker, lifting long horizontal bars and tying them into place can be problematic, especially if they are positioned overhead. If the bars have hooks, they'll tend to sag and twist, making them even more awkward to handle. Positioning long hooked bars in the proper location is difficult, and once installed, there are few means to adjust their locations.

Long horizontal bars with hooks at each end also require the ironworker to line up the bars in two planes. This is quite difficult, so the placed bars may violate concrete cover requirements at one or both ends. Even if all bars are correctly positioned at one end, however, the bars at the other end will usually be very uneven. The designer should keep these issues in mind and provide appropriate corner and intersection arrangements.

Wall bars are often assembled in curtains or mats that are lifted into position in the wall form. If the reinforcement curtains are to be preassembled in the shop or field, hooks would complicate preassembly, transportation, storage, and handling as well as make placement more difficult. Providing separate bars at intersections enhances constructibility by allowing adjacent panels to be installed without interference. The curtains can then be adjusted to maintain precise concrete cover as the independent hooked bars are being tied in place.

While the extra bar length and weight needed for lap splices may appear to be an inefficient use of material, the associated costs are usually more than offset by the increased production, handling, and installation efficiencies associated with preassembled curtains.

Single layer reinforcing layout

Figure 1 shows sectional plan views of intersections of walls reinforced with single layers of horizontal bars. Details a), b), and d) show bars with corner hooks on long horizontal bars. If possible, these hook arrangements



DETAILING CORNER

Joint ACI-CRSI Committee 315-B, Details of Concrete Reinforcement—Constructibility, has developed forums dealing with constructibility issues for reinforced concrete. Staff at the Concrete Reinforcing Steel Institute (CRSI) are presenting these topics in a regular series of articles. CRSI staff will also respond to requests for information (RFIs) regarding design, detailing, and construction. If you'd like to suggest an article topic or submit an RFI for this feature, please send an e-mail to Neal Anderson, CRSI's Vice President of Engineering, at nanderson@crsi.org with the subject line "Detailing Corner."

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should be avoided. As indicated previously, they can hinder installation or make it difficult to preassemble and install reinforcement curtains. Details c) and e) show the preferred solutions, with separate hooked bars at the wall intersections.

Double layer reinforcing layout

Figure 2 shows sectional plan views of intersections of walls reinforced with double layers of horizontal bars. For the 90-degree corner, Details a) and b) are examples of horizontal bars with hooks in both reinforcement planes. If possible, these schemes should be avoided, as they make it difficult to use preassembled curtains of bars. Although Detail c) is fairly common, Detail d) is preferred. Separate 90-degree hooked bars lapped with two preassembled double-bar curtains is generally considered to be very constructible. Detail e) provides an alternate layout that is also ideal for preassembled reinforcing bar curtains or precast wall panels. However, this detail can only be used in wall panels that are thick enough to accommodate the width of the hairpin or U bars. Keeping in mind that the minimum width of a 180-degree hook is eight bar diameters for No. 8 (No. 25) and smaller bars and 10 bar diameters for No. 9, 10, and 11 (No. 29, 32, and 36) bars, and noting as well that the detail should allow for a +1 in. (+25 mm) fabrication tolerance, this limitation can be significant.

For tee-intersections, Detail f) is similar to Details a) and b) for the 90-degree corner. Again, this detail should be avoided if possible. Detail g) illustrates the preferable reinforcing bar layout, showing separate hooked bars lapped with preassembled bar curtains. If the wall is thick enough, Detail h) is a potential variation of

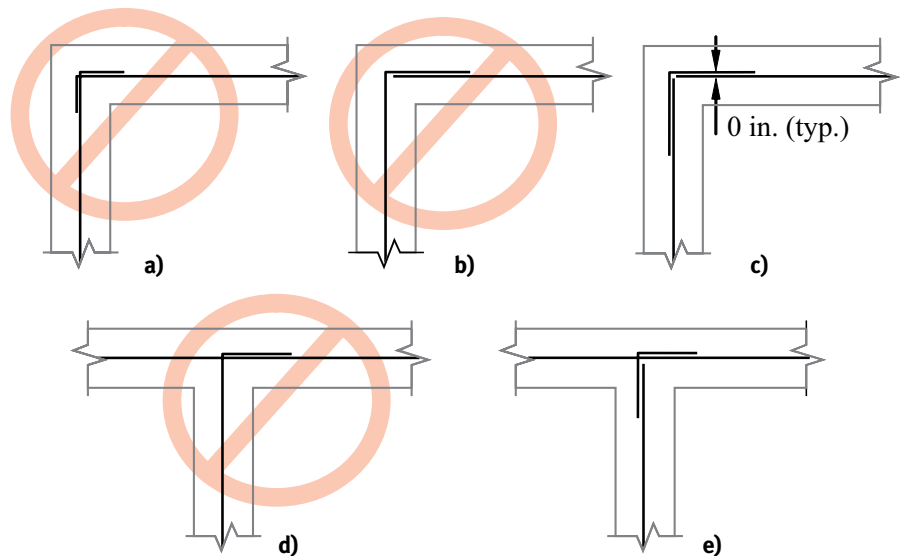


Fig. 1: Sectional plan views showing intersections of walls reinforced with single layer of horizontal bars

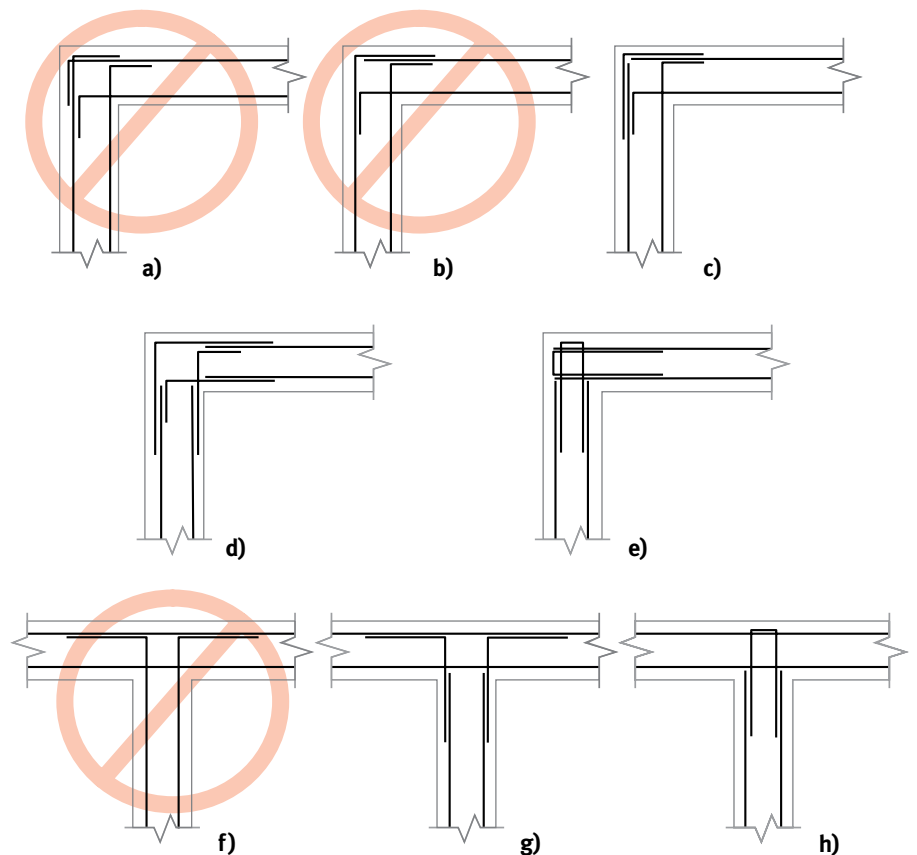


Fig. 2: Sectional plan views showing intersections of walls reinforced with double layers of horizontal bars

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Detail e), where a hairpin or U bar is lap-spliced with the double-bar curtain of the terminated wall section.

Horizontal hooks can be good

Ironically, there are certain situations where hooks on the horizontal bars provide advantages. In Fig. 3, Details a) and b) illustrate ideal horizontal bar arrangements for small concrete structures, where the bar length is in the 8 to 10 ft (2.4 to 3 m) range. Detail a) would be typical of a catch basin or sump detail. Detail b) is an example of a grease pit or acid pit. Because these structures are small, dimensions can be easily measured and the reinforcing steel precisely located as it is being assembled.

In Detail a), the dimension is fixed in one direction and can be adjusted in the other direction. If the structure is square, the bar arrangement can be alternately rotated 90 degrees to fix the dimensions in both directions. In Detail b), the dimensions are adjustable for all four walls and bars can be precisely adjusted for proper concrete cover. In some instances, the tails on the 90-degree hook can be extended beyond the normal 12-bar-diameter dimension to provide added adjustability to meet tolerances. In both Details a) and b), care must be taken to ensure that the dimensions of the bars do not exceed shipping limitations, as discussed in an earlier Detailing Corner article.¹

SUMMARY

When long runs of horizontal bars are required, end hooks should be avoided if possible. To facilitate necessary

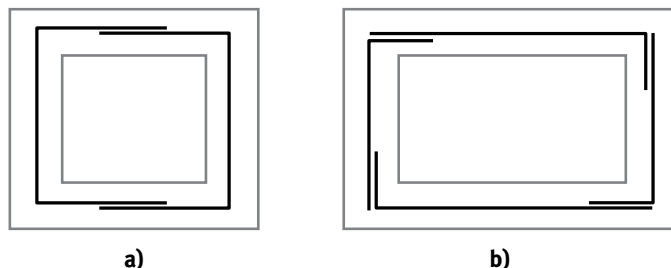


Fig. 3: For small concrete structures such as basins, sumps, or pits, hooks at the ends of horizontal bars can provide advantages

tolerance and cover requirements, separate 90-degree (corner) hooked bars should be used and lapped with straight lengths of horizontal bars. For structures requiring only short runs of horizontal bars, however, hooks at one or both ends can be advantageous, as the installed dimensions can be better controlled and the reinforcing bars are more easily assembled.

Reference

1. "Reinforcing Bars Exceeding Stock Lengths," *Concrete International*, V. 31, No. 1, Jan. 2009, pp. 50-51.

Thanks to Joint ACI-CRSI Committee 315 member Dick Birley, President of Condor Rebar Consultants, Inc., in Vancouver, BC, Canada, for providing the information in this article.

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piece of form chamfer strip or nominal 1 in. (25 mm) dimension lumber strip nailed to the formwork deck near the slab edge. Usually, the required concrete cover can be achieved by offsetting the bars crossing the groove (Fig. 2(a)). Alternatively, the transverse and longitudinal layers can perhaps be reversed and the affected reinforcing bar (open circle) can be moved away from the groove to achieve the proper concrete cover (Fig. 2(b)).

BEAMS

A drip groove or edge in a beam soffit oftentimes presents a concrete cover problem (Fig. 3(a)). Increasing the concrete cover in the beam soffit when the beam

steel is placed isn't feasible. Raising the stirrups from the bottom to achieve the proper cover will decrease the concrete cover at the top (Fig. 3(b)). The only practical solution is to measure the concrete cover from the drip groove and detail the stirrups accordingly (Fig. 3(c)). This may impact the overall depth of the beam and should be accounted for in design.

FORMLINERS

Architectural formliners provide an inexpensive means of enhancing the visual characteristics of a concrete surface. When formliners are used, the specified concrete cover is generally measured from an interior working line, which represents the maximum

RFI ON WALL CORNER JOINTS

RFI 10-1: In the November 2009 Detailing Corner, I have concerns with two of the figures, Fig. 09-3.1(a) and (b) on p. 56. Unlike Fig. 09-3.1(c), (a) and (b) will provide inadequate anchorage for the compressive strut that will form across the diagonal in the corner under a large opening moment. My concern is the lack of support for the outward force component from the strut. The hooks need to be turned into the joint, not turned into the adjacent wall. The newly added diagonal bar helps, but not to anchor the strut.

Response: Point taken. The details shown in Fig. 09-3.1, in which a diagonal bar was added in the corner, were meant as improved details of those that originally appeared in Fig. 2 of the September 2009 Detailing Corner. As was noted in RFI 09-3, the details shown were

intended for low levels of moment capacity in the wall and further detailing adjustments would be necessary for moderate or high levels of moment capacity.

To demonstrate the effect the reinforcement details have on the moment capacity of a corner, Fig. 10-1.1 presents various reinforcement details and their moment capacity ratings, which were calculated as the actual moment failure load divided by the calculated moment capacity.¹ As noted in the query, turning the hooks into the joint as well as adding the diagonal bar (Fig. 10-1.1(g)) results in a moment capacity that exceeds the corner's calculated capacity.

Reference

1. Nilsson, I.H.E., and Losberg, A., "Reinforced Concrete Corners and Joints Subjected to Bending Moment," *Journal of the Structural Division*, ASCE, V. 102, No. ST6, 1976, pp. 1229-1254.

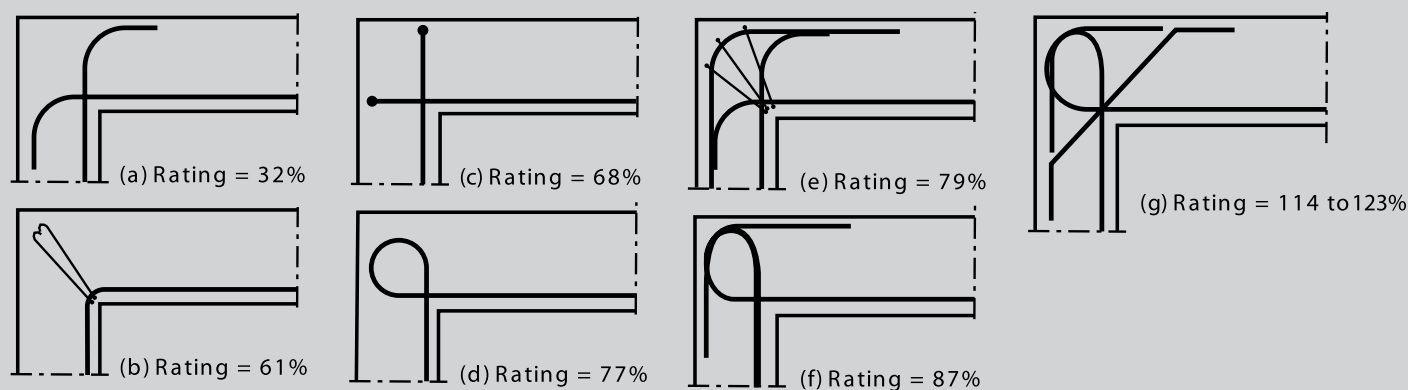


Fig. 10-1.1: Efficiency ratings (quotient of measured capacity and calculated capacity) for different reinforcement details (based on Reference 1)