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October 5, 2009

Memorandum to: Members ACI/CRSI Committee 315 - Details of Concrete Reinforcement

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From: Anthony L. Felder

Secretary

Subject: Meeting Notice and Agenda

November 8, 2009
New Orleans Marriott
New Orleans, Louisiana

Our next meeting will be held on Sunday, November 8, 2009 from 2:00 p.m. to 5:00 p.m. in Studio 7 of the New Orleans Marriott.

A proposed agenda is attached.

Copy to: David J. Bird
Daniel W. Falconer, ACI Technical Director
AGENDA
ACI/CRSI COMMITTEE 315 - DETAILS OF CONCRETE REINFORCEMENT

November 8, 2009

1. 2:00 p.m. - call meeting to order

2. Approval of minutes of last meeting, March 15, 2009, distributed June 3, 2009

3. Committee membership changes since last meeting. See Exhibit 1, current roster.

4. ACI/CRSI 315 Standard
   a. Continue discussion of 315 Standard’s future: submission of revisions to ACI 318, 301, and 117.
   b. Task Group report: outline of new 315 document (Hall, Hetherington, Hunter, Sebastian)
   c. Reapproval of ACI 315-99


   Secretary's Note: Subcommittee B is scheduled to meet on Sunday, November 8, 2009 from 8:30 a.m. to 11:30 a.m. in the Jackson Room of the New Orleans Marriott.

6. Detailing Corner column. See Exhibit 2.


8. New business
ACI/CRSI COMMITTEE 315 ROSTER
Oct 2009

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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...
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
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.

**SUMMARY**

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


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.

Selected for reader interest by the editors.
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February 25, 2009

From: Dick Birley

Subject: 315B – Constructibility Task Group – Issues regarding Nuclear Verbatim Compliance

Members: Dennis Hunter, Robbie Hall, Greg Birley, Jay Hetherington, Dick Birley

To: Committee 315 – Detailing

At the Committee 315 meeting Nov 2, 2008, in St. Louis, Greg Birley raised the issue of Nuclear Verbatim Compliance. Condor Rebar Consultants Inc has been experiencing difficulties having its detailing approved because numerous bar shapes we have called up are not found in ACI Detailing Manual – 2004. The reviewers, noting that there must be Verbatim Compliance to all codes and standards, take the view that if a bar shape is not shown in the Manual it is therefore a non-complying shape. In every instance a Non-Compliance Report is issued against Condor. We must then issue an RFI asking for the non-complying shape to be approved for use on the project.

It is clear that construction of nuclear reactors is about to make a remarkable comeback. It is therefore important for the entire reinforcing steel industry that this Committee resolve this bar shape issue as quickly as possible.

To that end, a Task Group was struck to develop a solution. We are pleased to submit the following report.

Regards,

Dick Birley, Chairman
Task Group – Issues regarding Nuclear Verbatim Compliance

Verbatim Compliance as defined by QA/QC programs on recent nuclear construction projects means that any bend shape that is not described in the ACI Detailing Manual – 2004 list of typical bar bends is a non-complying bar. In each instance, an RFI requesting approval of the shape must be issued. This Task Group was charged with the task of recommending changes to the ACI Detailing Manual that would cover all possible bar shapes.

TASK GROUP RECOMMENDATIONS

The Task Group makes four general recommendations: reorganize the section of the Manual dealing with bar shapes to show a more logical progression of data, make a general statement about Typical Bar Bends, modify "Notes:" on pages 32 and 33, and present a guideline for all bend shapes.

Organization of Detailing Manual

Present bar bend data in the following order:

1. Typical Bar Bends (Pages 32 and 33 in current manual)
2. Hook Data (Pages 43 and 44 in current manual)
3. Guidelines for Bar Bends (Presented in this document)
4. Fabrication Tolerances (Pages 29, 30 and 31 in current manual)

Typical Bar Bends Statement

Insert the following qualifying statement on current Pages 29 through 33:

"The typical bar bends shown above represent only the most common shapes encountered in normal concrete construction. It is possible that other shapes will be required. Other shapes are acceptable provided they follow the conventions listed in "Guidelines for Bar Bends" on Page ___."

Modify "Notes:"

Rearrange and modify "Notes:" on pages 32 and 33 to read as follows:

1. Figures in circles show types.
2. All dimensions are out-to-out of bar except "A" and "G" on standard 180° and 135° hooks.
3. "J" dimensions on 180° hooks to be shown only where necessary to restrict hook size; otherwise ACI standard hooks are to be used.
4. Where "J" is not shown, "J" will be kept equal to or less than "H" on Types such as 3, 5, and 22. Where "J" can exceed "H", it should be shown.
5. "H" dimension stirrups to be shown where necessary to fit within concrete.
6. Where bars are to be bent more accurately than standard fabricating tolerances, bending dimensions that require closer fabrication should have limits indicated.
7. For recommended diameter "D" of bends and hooks, see Section 3.7.1; for recommended hook dimensions, hook dimensions, see Table 1.
8. Type S1 through S6, S11, T1 through T3, and T6 through T9, apply to bar sizes No. 3 through 8 (No. 10 through 25).
9. Unless otherwise noted, diameter "D" is the same for all bends and hooks on a bar (except for Types such as 11 and 13).
Guidelines for Bar Bends

- Stirrups and ties confining vertical or longitudinal bars in members such as columns and beams are treated as “S” and “T” shapes in the Typical Bar Bends schedule and are bent on pin sizes listed in the schedules on Page 44 of the current ACI Detailing Manual – 2004.

- A and G leg dimensions always denote standard hooks as defined by ACI 318 except for types such as 10, 14, and T3. (See P44 in the current ACI Detailing Manual – 2004.

- Leg dimensions A through G are additive dimensions that are used to produce total length.

- Leg dimensions H, J, K, O and R are always descriptive dimensions and are not added into the total length. Generally, though not necessarily always, these dimensions are used as described below:
  - H – height (vertical dimension) of a sloping leg
    - (except for types such as S1, S2 and S3 where it is the depth of the hook)
    - (height of types such as 9, 11, 25 and S11)
  - J – depth of hook
    - (may be used in lieu of H when multiple sloping legs with different angles are required)
  - K – width (horizontal dimension) of a sloping leg
  - O – Overall length
    - (may be used in lieu of K when multiple sloping legs with different angles are required)
  - R – radius
  - Multiple sloping legs on a single bar may also be described as H/K, H1/K1, H2/K2, etc.

- Leg dimensions F and R may not be used together on the same bar type.

- If a bar type contains two hooks, they must both be of the same class, i.e. either standard hooks or stirrup/tie hooks.

- Types “25”, “26”, and other shapes used as standees are treated the same as “S” and “T” bend types for bending purposes, i.e. bent on smaller pins than regular bend shapes.

- For legs of all bend shapes, except for end hooks, labeling begins with “B” and follows in sequence to “F” for succeeding sides with no letters omitted. There may be exceptions such as Type 7.

- A bar shape may be called up with sides omitted to achieve a desired shape. For example, a bar with a single standard hook may be described as Type 2 with only “A” and “B” dimensions indicated. A corner bar may be described as Type 17 with only “B” and “C” dimensions indicated.

- Identical sides on combination ties are labeled with the same letter as illustrated in Sketch 1.

- Measurement of bent bars to be as follows:
  - All dimensions are measured out-to-out except for sides “A” and “G” which are measured as indicated on Page 44 of the current ACI Detailing Manual – 2004
  - Straight bars are measured end to end as shown in Sketch 2
  - Bends between 1° and 89° measured to intersection of sides as shown in Sketch 3
  - 90° bends measured to intersection of sides as shown in Sketch 4
  - Bends between 91° and 179° measured to tangents of bend as shown in Sketch 5
  - 180 bends measured to sides and tangent as shown Sketch 6
  - “Z” bars measured to intersection of sides as shown on Sketch 7
Sketch 1

Combination or 'multi' tie

Sketch 2

Straight Bars

Sketch 3

Bends between 1 and 89 degrees

Sketch 4

90 degree bends

Sketch 5

Bends between 91 and 179 degrees

Sketch 6

180 degree bends

Sketch 7

"Z" bar
Details and Detailing of Concrete Reinforcement (ACI 315-99)

Reported by ACI Committee 315

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This document provides standards of practice for both the architect/engineer (A/E) and reinforcing steel detailer in showing reinforcing steel details. It is divided into three parts: one addressed to the A/E, one for the detailer, and a third providing reference tables and figures. It defines the responsibilities of both the A/E and detailer. It then establishes certain standards of practice for both the structural and placing drawings.

Keywords: beams (supports); bending (reinforcing steels); bridges (structures); buildings; columns (supports); concrete slabs; detailing; drafting (drawing); fabrication; floor systems; foundations; hooked reinforcing steels; microcomputers; placing drawings; reinforced concrete; reinforcing steels; splicing; stirrups; structural design; structural drawings; ties; tolerances (mechanics); walls; welded wire fabric.

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FOREWORD

Increased use of computers has led to sophisticated techniques of structural analysis and has increased manufacturing and fabrication capabilities. This added degree of...
TOLERANCE SYMBOLS

1 = ±1/2 in. (15 mm) for bar size No. 3, 4, and 5 (No. 10, 13, and 16)  
   (gross length < 12 ft. 0 in. (3650 mm))
2 = ±1 in. (25 mm) for bar size No. 3, 4, and 5 (No. 10, 13, and 16)  
   (gross length ≥ 12 ft. 0 in. (3650 mm))
3 = ±1 in. (25 mm) for bar size No. 6, 7, and 8 (No. 19, 22, and 25)
4 = ± 1 in. (25 mm)
5 = ± 1/4 in. (15 mm)
6 = ± 1/2 in. (15 mm) for diameter ≤ 30 in. (760 mm)
7 = ± 1 in. (25 mm) for diameter > 30 in. (760 mm)
8 = ± 1.5% × "O" dimension, ≥ ± 2 in. (50 mm) minimum

Note: All tolerances single plane and as shown.

*Dimensions on this line are to be within tolerance shown but are not to differ from the opposite parallel dimension more than 1/2 in. (15 mm).

**Angular deviation—maximum ± 2-1/2 degrees or ± 1/2 in./ft (40 mm/m), but not less than 1/8 in. (15 mm) on all 90 degree hocks and bends.

***Application of positive tolerance to Type 9 results in a chord length ≥ the arc or bar length, the bar may be shipped straight.

Tolerances for Types S1-S6, S11, T1-T3, T6-T9 apply to bar size No. 3 through 8 (No. 10 through 25) inclusive only.

Fig. 8—Standard fabricating tolerances for bar sizes No. 3 through 11 (No. 10 through 36).
TOLERANCE SYMBOLS

1 = ±1/2 in. (15 mm) for bar size No. 3, 4, and 5 (No. 10, 13, and 16) (gross length < 12 ft. 0 in. (3650 mm))
1 = ±1 in. (25 mm) for bar size No. 3, 4, and 5 (No. 10, 13, and 16) (gross length ≥ 12 ft. 0 in. (3650 mm))
1 = ±1 in. (25 mm) for bar size No. 6, 7, and 8 (No. 19, 22, and 25)
2 = ± 1 in. (25 mm)
3 = ± 0. ±1/2 in. (15 mm)
4 = ±1/2 in. (15 mm)
5 = ±1/2 in. (15 mm) for diameter ≤ 30 in. (760 mm)
5 = ±1 in. (25 mm) for diameter > 30 in. (760 mm)
6 = ±1.5% × "O" dimension, ≥ ± 2 in. (50 mm) minimum

Note: All tolerances single plane and as shown.

"Dimensions on this line are to be within tolerance shown but are not to differ from the opposite parallel dimension more than 1/2 in. (15 mm).
"Angular deviation—maximum ± 2-1/2 degrees or ± 1/2 in./ft (40 mm/m), but not less than 1/2 in. (15 mm) on all 90 degree hooks and bends.
"If application of positive tolerance to Type 9 results in a chord length ≥ the arc or bar length, the bar may be shipped straight.
Tolerances for Types S1-S6, S11, T1-T3, T6-T9 apply to bar size No. 3 through 8 (No. 10 through 25) inclusive only.

Fig. 8 (cont.)—Standard fabricating tolerances for bar sizes No. 3 through 11 (No. 10 through 36).
Note: All tolerances single plane as shown.

- Saw-cut both ends—Overall length ± 1/2 in. (15 mm).
- Angular deviation—Maximum ± 2 1/2 degrees or ± 1/2 in./ft (40 mm/m) on all 90 degree hooks and bends.
- Application of positive tolerance to Type 9 results in a chord length ≥ the arc or bar length, the bar may be shipped straight.

Fig. 9—Standard fabricating tolerances for bar sizes No. 14 and 18 (No. 43 and 57).
Notes:
1. All dimensions are out-to-out of bar except "A" and "G" on standard 180 and 135 degree hooks.
2. "J" dimensions on 180 degree hooks to be shown only where necessary to restrict hook size, otherwise ACI standard hooks are to be used.
3. Where "J" is not shown, "J" will be kept equal or less than "H" on Types 3, 5, and 22. Where "J" can exceed "H" it should be shown.
4. "H" dimension stirrups to be shown where necessary to fit within concrete.
5. Where bars are to be bent more accurately than standard fabricating tolerances, bending dimensions that require closer fabrication should have limits indicated.
6. Figures in circles show types.
7. For recommended diameter "D" of bends and hooks, see Section 3.7.1; for recommended hook dimensions, see Table 1.
8. Unless otherwise noted, diameter "D" is the same for all bends and hooks on a bar (except for Types 11 and 13).

Where slope differs from 45° dimensions, "H" and "K" must be shown.

ENLARGED VIEW SHOWING BAR BENDING DETAILS

Fig. 10—Typical bar bends.
Notes:
1. All dimensions are out-of-bar except “A” and “G” on standard 180 and 135 degree hooks.
2. “J” dimensions on 180 degree hooks to be shown only where necessary to restrict hook size, otherwise ACI standard hooks are to be used. 
3. Where “J” is not shown, “J” will be kept equal or less than “H” on Types 3, 5, and 22. Where “J” can exceed “H”, it should be shown.
4. “H” dimension slits ups to be shown where necessary to fit within concrete.
5. Where bars are to be bent more accurately than standard fabricating tolerances, bending dimensions that require closer fabrication should have limits indicated.
6. Figures in circles show types.
7. For recommended diameter “D” of bends and hooks, see Section 3.7.1; for recommended hook dimensions, see Table 1.
8. Type S1 through S6, S11, T1 through T3, T6 through T9: apply to bar sizes No. 3 through 8 (No. 10 through 25).
9. Unless otherwise noted, diameter “D” is the same for all bends and hooks on a bar (except for Types 11 and 13).

Fig. 10 (cont.)—Typical bar bends.
Table 1—Standard hooks: All specific sizes recommended meet minimum requirements of ACI 318

![Diagram of hook dimensions](image)

**RECOMMENDED END HOOKS**

**All grades**

**D = Finished bend diameters**

<table>
<thead>
<tr>
<th>Bar size, No.</th>
<th>D, in (mm)</th>
<th>180 degree hook</th>
<th>90 degree hook</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A or G, ft-in (mm)</td>
<td>J, ft-in. (mm)</td>
<td>A or G, ft-in. (mm)</td>
</tr>
<tr>
<td>3 (10)</td>
<td>2 1/4 (60)</td>
<td>5 (125)</td>
<td>3 (80)</td>
</tr>
<tr>
<td>4 (13)</td>
<td>3 (80)</td>
<td>6 (155)</td>
<td>4 (105)</td>
</tr>
<tr>
<td>5 (16)</td>
<td>3 3/4 (95)</td>
<td>7 (180)</td>
<td>5 (130)</td>
</tr>
<tr>
<td>6 (19)</td>
<td>4 1/2 (115)</td>
<td>8 (205)</td>
<td>6 (155)</td>
</tr>
<tr>
<td>7 (22)</td>
<td>5 1/4 (135)</td>
<td>10 (250)</td>
<td>7 (175)</td>
</tr>
<tr>
<td>8 (25)</td>
<td>6 (155)</td>
<td>11 (275)</td>
<td>8 (205)</td>
</tr>
<tr>
<td>9 (29)</td>
<td>9 1/2 (240)</td>
<td>1-3 (375)</td>
<td>11 3/4 (300)</td>
</tr>
<tr>
<td>10 (32)</td>
<td>10 3/4 (275)</td>
<td>1-5 (425)</td>
<td>1-1 1/4 (335)</td>
</tr>
<tr>
<td>11 (36)</td>
<td>12 (305)</td>
<td>1-7 (475)</td>
<td>1-2 3/4 (375)</td>
</tr>
<tr>
<td>12 (43)</td>
<td>18 1/4 (465)</td>
<td>2-3 (675)</td>
<td>1-9 3/4 (550)</td>
</tr>
<tr>
<td>18 (57)</td>
<td>24 (610)</td>
<td>3-0 (925)</td>
<td>2-4 1/2 (725)</td>
</tr>
</tbody>
</table>

*Finished bend diameters include "spring back" effect when bars straighten out slightly after being bent and are slightly larger than minimum bend diameters in 3.7.2.
Table 1 (cont.)—Standard hooks: All specific sizes recommended meet minimum requirements of ACI 318

**STIRRUP AND TIE HOOKS**

<table>
<thead>
<tr>
<th>Bar size, No.</th>
<th>D, in. (mm)</th>
<th>90 degree hook</th>
<th>135 degree hook</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (10)</td>
<td>1 1/2 (40)</td>
<td>4 (105)</td>
<td>4 (105)</td>
</tr>
<tr>
<td>4 (13)</td>
<td>2 (50)</td>
<td>4 1/2 (115)</td>
<td>4 1/2 (115)</td>
</tr>
<tr>
<td>5 (16)</td>
<td>2 1/2 (65)</td>
<td>6 (155)</td>
<td>5 1/2 (140)</td>
</tr>
<tr>
<td>6 (19)</td>
<td>4 1/2 (115)</td>
<td>1-0 (305)</td>
<td>8 (205)</td>
</tr>
<tr>
<td>7 (22)</td>
<td>5 1/4 (135)</td>
<td>1-2 (355)</td>
<td>9 (230)</td>
</tr>
<tr>
<td>8 (25)</td>
<td>6 (155)</td>
<td>1-4 (410)</td>
<td>10 1/2 (270)</td>
</tr>
</tbody>
</table>

**135° SEISMIC STIRRUP/TIE HOOKS**

<table>
<thead>
<tr>
<th>6d, 3 in. (75 mm) min.</th>
</tr>
</thead>
</table>

**STIRRUP (TIES SIMILAR) STIRRUP AND TIE HOOK DIMENSIONS ALL GRADES**

<table>
<thead>
<tr>
<th>Bar size, No.</th>
<th>D, in. (mm)</th>
<th>135 degree hook</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (10)</td>
<td>1 1/2 (40)</td>
<td>4 1/4 (110)</td>
</tr>
<tr>
<td>4 (13)</td>
<td>2 (50)</td>
<td>4 1/2 (115)</td>
</tr>
<tr>
<td>5 (16)</td>
<td>2 1/2 (65)</td>
<td>5 1/2 (140)</td>
</tr>
<tr>
<td>6 (19)</td>
<td>4 1/2 (115)</td>
<td>8 (205)</td>
</tr>
<tr>
<td>7 (23)</td>
<td>5 1/4 (135)</td>
<td>9 (230)</td>
</tr>
<tr>
<td>8 (25)</td>
<td>6 (155)</td>
<td>10 1/2 (270)</td>
</tr>
</tbody>
</table>

*Finished bend diameters include “spring back” effect when bars straighten out slightly after being bent and are slightly larger than minimum bend diameters in 3.7.2.*