October 26, 2015

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

Voting Members:

Gregory P. Birley          Dennis L. Hunter          Mustafa A. Mahamid
Richard H. Birley          David W. Johnston         Javed B. Malik
David A. Grundler          Mahmoud E. Kamara         Christopher J. Perry
Robert W. Hall             William M. Klorman        Curtis Yokoyama
Todd R. Hawkinson          Douglas D. Lee            Peter Zdgiebloski

Associate/Consulting/Subcommittee Members:

Paul B. Aubee               Garrick N. Goldenberg     Thomas G. Schmaltz
Paul J. Brienen             Paul Gordon                William G. Sebastian
Larry Campbell              James S. Lai              Avanti C. Shroff
David H. DeValve            Amadeus L. Magpile       Richard W. Stone
Pedro Estrada               David R. Maul              Richard D. Thomas
Dennis J. Fontenot          Harold E. Reed            Farahad Zahedi
Peter Fosnough              Dale Rinehart

From: Anthony L. Felder
      Secretary

Subject: Meeting Notice and Agenda
November 8, 2015
Sheraton Denver Downtown Hotel
Denver, CO

Our next meeting will be held on Sunday, November 8, 2015 from 2:00 p.m. to 5:00 p.m. in the Tower Court D of the Marriott and Sheraton Denver Downtown Hotel in Denver, CO.

A proposed agenda is attached.

Copy to: Eldon Tipping, TAC Contact
AGENDA
ACI/CRSI COMMITTEE 315 - DETAILS OF CONCRETE REINFORCEMENT

Sheraton Denver Downtown, Denver, CO
November 8, 2015 2:00 – 5:00 Tower Court D

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

2. Self-introductions

3. Approval of minutes of last meeting, April 12, 2015, distributed May 15, 2015

4. Review committee membership. See Exhibit 1, current roster.

5. Presentation by Mike Mota (CRSI) and Matt Senecal (ACI) regarding future strategic cooperation of the detailing committees of both organizations
   a. Questions
   b. Discussion

6. Status Reports
   a. ACI 131 BIM / CRSI BIM - Pete Zdgiebloski
   b. CRSI Detailing - Dave Grundler
   c. CRSI (Placing, Fabrication, Supports) - Robbie Hall

7. Task Group activities since Kansas City meeting
   a. Name change from “Details of Concrete Reinforcement” to “Designer’s Guide to Reinforcing Bar Detailing”
   b. Chapter 1 – Introduction
   c. Chapter 3 – Structural Drawings
   d. Chapter 4 – Placing Drawings
   e. Chapter 5 – Reviewing Placing Drawings
   f. Chapter 6 – Tolerances
   g. Chapter 7 – Detailing Issues for the Designer
   h. Chapter 8 – Fabrication and Construction Issues
   i. Chapter 9 – References
   j. Chapter X – Design Details

8. Other Committee activities:
   a. Constructability Forums
   b. Articles for Concrete International

9. New Business

10. Motion to Adjourn
Richard H. Birley, Chairman  
Condor Rebar Consultants  
1128 Hornby Street, 3rd Floor  
Vancouver, British Columbia V6Z 2L4  
Tel: 604/689-9201  
Fax: 604/689-9206  
E-mail: dick.birley@condor-rebar.com

Paul J. Brienen*  
Brienen Structural Engineers, PS  
14114 SE 278th St  
Kent, WA 98042-7406  
Tel: 206/397-0000  
Fax:  
E-mail: pbrienen@bse-ps.com

Anthony L. Felder, Secretary  
Concrete Reinforcing Steel Institute  
933 N. Plum Grove Road  
Schaumburg, IL 60173-4758  
Tel: 847/517-1200  
Fax: 847/517-1206  
E-mail: afelder@crsi.org

Larry Campbell*  
CMC Rebar  
5913 Diamond Oaks Ct  
Haltom City, TX 76117-2802  
Tel: 817/734-2838  
Fax:  
E-mail: larry.campbell@cmc.com

Eldon Tipping, TAC Contact  
Structural Services Inc.  
115 Park Place Blvd, Ste 300  
Waxahachie, TX 75165-9206  
Tel: 214/522-6438  
Fax: 214/522-6796  
E-mail: etipping@ssiteam.com

David H. DeValve*  
Oklahoma Steel & Wire  
1041 S. 1st  
Madill, OK 73446-0220  
Tel: 580/795-6007  
Fax: 580/795-7422  
E-mail: ddevalse@oklahomasteel.com

Paul B. Aubee*  
Insteel Wire Products  
1373 Boggs Dr  
Mount Airy, NC 27030-2145  
Tel: 800/334-9504  
Fax:  
E-mail: paubee@insteel.com

Pedro Estrada*  
PEG Ongenieria C A  
88-60 Calle Los Guayos  
Urb Trigal Centro  
Valencia 2001 Venezuela  
Tel: 58-241 8428964  
E-mail: pestradag@gmail.com

Gregory P. Birley  
Condor Rebar Consultants  
1128 Hornby Street, 3rd Floor  
Vancouver, British Columbia V6Z 2L4  
Tel: 604/692-2168  
Fax: 604/689-9206  
E-mail: greg.birley@condor-rebar.com

Dennis J. Fontenot*  
Commercial Metals Company  
12001 Mystic Forest Ln  
Austin, TX 78739-4813  
Tel: 512/523-3398  
Fax:  
E-mail: dennis.fontenot@cmc.com

* - Associate Member  
** - Consulting Member  
*** - Subcommittee Member
Peter Fosnough*  
Harris Rebar-Ambassador Steel  
1342 S Grandstaff Dr.  
Auburn, IN 46706-2661  
Tel: 260/572-1227  
Fax: 260/925-3152  
E-mail: pfosnough@harrisrebar.com

Dennis L. Hunter  
Gerdau  
2100 Joe McIntosh Road  
Plant City, FL 33565-7413  
Tel: 813/740-3301  
Fax: 813/740-3401  
E-mail: dennis.hunter@gerdau.com

Garrick N. Goldenberg*  
Goldenberg Associates, Inc.  
26 Tisdale Dr.  
Dover, MA 02030-1600  
Tel: 508/481-7400  
Fax: 508/481-7406  
E-mail: garrickg@wit.edu

David W. Johnston  
North Carolina State University  
Civil Engineering Department  
Raleigh, NC 27695-0001  
Tel: 919/515-7412  
Fax: 919/515-7908  
E-mail: johnston@ncsu.edu

David A. Grundler  
Applied Systems Associates  
5270 Logan Ferry Road  
Murrysville, PA 15668-9727  
Tel: 724/733-8700  
Fax: 724/325-5553  
E-mail: David.Grundler@asahq.com

Mahmoud E. Kamara  
StructurePoint  
2021 N Charter Point Dr.  
Arlington Heights, IL 60004-7258  
Tel: 847/259-5499  
Fax:  
E-mail: mekamara10@hotmail.com

Robert W. Hall  
Gerdau  
1255 Lakes Parkway, Ste. 325  
Lawrenceville, GA 30043-5818  
Tel: 678/367-6036  
Fax: 678/367-6001  
E-mail: Robbie.Hall@gerdau.com

William M. Klorman  
W M Klorman Const Corp.  
23047 Ventura Blvd, 2nd Floor  
Woodland Hills, CA 91364-1146  
Tel: 818/591-5969  
Fax: 818/591-5926  
E-mail: bklorman@klorman.com

Todd R. Hawkinson  
Wire Reinforcement Institute  
323 Fox Briar Lane  
Ballwin, MO 63021-6151  
Tel: 314/807-4386  
Fax: 636/227-3776  
E-mail: todd@hawkinsonassociates.com

James S. Lai*  
Lai Associates  
PO Box 517  
La Canada Flintridge, CA 91012-0517  
Tel: 818/790-5475  
Fax:  
E-mail: jslai@sbcglobal.net

* - Associate Member  ** - Consulting Member  *** - Subcommittee Member
Douglas D. Lee  
Douglas D. Lee & Associates  
6150 Foxglove Court  
Fort Worth, TX 76112-1106  
Tel: 817/457-7030  
Fax: 817/457-8970  
E-mail: ddlee4836@sbcglobal.net

Amadeus L. Magpile**  
Barlines Rebar Est. & Det.  
2871 W. Carson St.  
Torrance, CA 90503-6068  
Tel: 310/618-8402  
Fax: 310/618-8394  
E-mail: amagpile@barlines.com

Mustafa A. Mahamid  
University of Illinois at Chicago  
842 W Taylor St  
Chicago, IL 60607-7021  
Tel: 312/355-0364  
Fax:  
E-Mail: mmahamid@uic.edu

Javed B. Malik  
Jacobs Engineering Group  
5985 Rogerdale Rd  
Houston, TX 77072-1601  
Tel: 281/776-2540  
Fax: 281/776-2501  
E-mail: javed.malik@jacobs.com

David R. Maul*  
Davis Wire Corp.  
5555 Irwindale Ave  
Irwindale, CA 91706-2046  
Tel: 626/893-7426  
Fax:  
E-Mail: dmaul@daviswire.com

Christopher J. Perry  
Perry & Associates, LLC  
221 N LaSalle St., Ste. 3100  
Chicago, IL 60601-1206  
Tel: 312/364-9112  
Fax: 312/364-9163  
E-Mail: ejperry@PerryLLC.com

Harold E. Reed***  
Davis Wire  
85139 Appletree Dr.  
Eugene, OR 97405-9702  
Tel: 541/912-3195  
Fax:  
E-mail: hreed@daviswire.com

Dale Rinehart**  
Sierra Rebar LLC  
10480 E 96th Ave.  
Henderson, CO 80640  
Tel: 303/558-0015  
Fax: 720/358-4101  
E-mail: drinehart@sierrarebar.com

Thomas G. Schmaltz**  
Precision Rebar & Accessories, Inc.  
1712 NE 99th Street  
Vancouver, WA 98665-9018  
Tel: 360/574-1022  
Fax: 503/224-7414  
E-mail: jerry@precision-rebar.com

William G. Sebastian**  
American Rebar Detailing, LLC  
543 Wright Loop  
Williamstown, NJ 08094-1224  
Tel: 856/728-6645  
Fax: 856/728-0088  
E-mail: wsebastian@comcast.net

* - Associate Member  ** - Consulting Member  *** - Subcommittee Member
Avanti C. Shroff**
Iffland Kavanagh Waterburry
2 Penn Plaza, Ste 603
New York, NY 10121-0101
Tel: 212/946-2300
Fax: 212/302-4645
E-mail: avantishroff@comcast.net

Richard W. Stone*
Richard W. Stone, PE Inc.
1523 Richard Dr.
West Chester, PA 19380-6332
Tel: 484/639-5511
Fax:
E-mail: rwstone1523@gmail.com

Richard D. Thomas**
CMC Rebar Florida
2665 Prince St.
Fort Myers, FL 33916-5527
Tel: 239/337-3480
Fax: 239/337-3542
E-mail: dale.thomas@cmc.com

Curtis R. Yokoyama
Fluor
23 Danta
Rancho Santa Margarita, CA 92688-1514
Tel: 949/349-4118
Fax:
E-mail: curtis.yokoyama@fluor.com

Farshad Zahedi*
Babol Noshirvani University of Tech
Shariati Avenue, Moalem 4, White House
Babol, Mazandaran Iran
Tel: +9809111170600
Fax:
E-mail: farshad.zahedi@gmail.com

Peter Zdgiebloski
CMC Rebar
PO Box 1208
Madison Heights, VA 24572-1208
Tel: 434/522-8311
Fax: 434/929-1964
E-mail: peter.zdgiebloski@cmc.com

* - Associate Member  ** - Consulting Member  *** - Subcommittee Member
CHAPTER 1—INTRODUCTION

1.1—General

"ACI Designer’s Guide to Reinforcing Bar Detailing" was written to show LDP’s the information a reinforcing bar detailer needs to properly detail rebar and how to present that information on their structural drawings. It is not intended to instruct the LDP how to detail reinforcing steel. It is hoped that information in this guide on structural members of reinforced concrete structures will advance standardization through the detailing, fabrication, and installation of concrete reinforcement. The information presented herein complies with the requirements of the following ACI committees:

- ACI 318 – Building Code Requirements for Structural Concrete
- ACI 301 – Specifications for Structural Concrete
- ACI 117 – Tolerances
- ACI 131 – Building Information Modeling for Concrete Structures
- ACI 132 – Responsibilities in Concrete Construction

This guide is intended to facilitate clear communication between LDP’s, reinforcing bar detailers, fabricators, and placers by encouraging standard presentation of details and information.

1.2—Scope

This guide provides both general and specific information and illustrative details that are required by reinforcing steel detailers in steel reinforced concrete members such as slabs, beams, and columns. It stresses the importance of this information to ensure that the detailer effectively
and accurately captures the intent of the LDP and presents it in a manner that is clear and unambiguous to the rebar fabricator and placer.

2.0—Definitions

ACI provides a comprehensive list of definitions and terminology through an online resource:

“CT-13: ACI Concrete Terminology - An ACI Standard”

It can be downloaded without charge from the ACI website at:


3.0—BIM
CHAPTER 3 — STRUCTURAL DRAWINGS

3.1—Scope

This chapter describes information that is typically found on structural drawings. In US engineering practice each design office usually develops an “office standard” sheet order and naming convention. This guide, as an example, presents the project sheet order found in the United States National CAD Standard – V6, as outlined in 3.3.

3.2—General

Structural drawings are those prepared for the owner or purchaser of engineering services and along with the project specifications form a part of the contract documents. Structural drawings must contain an adequate set of notes, instructions and information necessary to permit the reinforcing steel detailer to produce reinforcing steel placing drawings.

Each sheet should have a title block, production data, and a drawing area as shown in Fig. 3.2.

The drawing area is the largest portion of the sheet where technical information is presented. Examples of technical information are the overall framing plan, sections and details needed to illustrate information at specific areas, and additional notes as required.

The production data area is located in the left margin of the sheet and includes information such as the CAD filename and path to the file, default settings, pen assignments, printer/plotter commands, date and time of plot, overlay drafting control data, and reference files.
The title block area is located at the right side of the sheet. It usually includes the designers name, address, and logo; basic information about the project including location of the worksite, owner, and project name; an information block regarding issue type (addendum, design development, bidding, bulletin, etc.) of this sheet; a sheet responsibility block that indicates the project manager, engineer, draftsman and reviewer of the information on the drawing; a sheet title block; and a sheet numbering block.

Figure 3.2- United National CAD standard overall sheet layout
3.3—Order of sheets

The order of drawings shown in the United States National CAD Standard – V6 is as follows:

<table>
<thead>
<tr>
<th>Sheet number</th>
<th>Sheet title</th>
<th>Information included</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>General notes</td>
<td>Symbols legend, general notes</td>
</tr>
<tr>
<td>1</td>
<td>Plans</td>
<td>Horizontal views of the project</td>
</tr>
<tr>
<td>2</td>
<td>Elevations</td>
<td>Vertical views</td>
</tr>
<tr>
<td>3</td>
<td>Sections</td>
<td>Sectional views, wall sections</td>
</tr>
<tr>
<td>4</td>
<td>Large-scale views</td>
<td>Plans, elevations, stair sections, or sections that are not details</td>
</tr>
<tr>
<td>5</td>
<td>Details</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Schedules and diagrams</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>User defined</td>
<td>For types that do not fall in other categories, including typical detail sheets</td>
</tr>
<tr>
<td>8</td>
<td>User defined</td>
<td>For types that do not fall in other categories</td>
</tr>
<tr>
<td>9</td>
<td>3D Representations</td>
<td>Isometrics, perspectives, photographs</td>
</tr>
</tbody>
</table>

If more than one sheet is required within the above order, then decimal sheet numbers are used, e.g., 5.0, 5.1, 5.2, 5.3.

3.4—Content of sheets

3.4.1 General notes sheets

A general notes sheet presents project design loads, the codes and standards that are the basis of design, material and product requirements, and construction directions. The notes can be the entire project structural specifications, act as an extension of the project structural specifications, or simply duplicate important aspects of the project structural specifications.
3.4.1.1 Codes and standards

The general building code, referenced standards, and/or the authority having jurisdiction requires specific information to be included on the construction documents and the general notes sheet(s) present this information. ACI 318 also requires that all applicable information from Chapter 26 related to construction be included in the construction documents.

3.4.1.2 Design loads

Section 1603.1 of the 2012 International Building Code (IBC) states: “The design loads and other information pertinent to the structural design required by Sections 1603.1.1 through 1603.1.9 shall be indicated on the construction documents.” The titles of these 9 referenced sections are listed below:

- 1603.1.1 Floor live load
- 1603.1.2 Roof live load
- 1603.1.3 Roof snow load data
- 1603.1.4 Wind design data
- 1603.1.5 Earthquake design data
- 1603.1.6 Geotechnical information
- 1603.1.7 Flood design data
- 1603.1.8 Special loads
- 1603.1.9 Systems and components requiring special inspections for seismic resistance

Design loads are presented on the general notes sheet. Floor live loads, roof live loads, snow loads, and other simple gravity loads are commonly shown in a table. Basic wind load
criteria assumptions and, when necessary, wind loading diagrams are included. Earthquake
design data is usually presented as a list of the different criteria used to develop the design
earthquake loads.

Geotechnical design information shown is usually supplied to the structural designer in a
gеotechnical report. It can be presented as a note if the soil and water table on site is relatively
consistent or in a table format if there is significant soil or water table variability.

Flood design data and criteria used to determine the flood design loads are typically
shown using notes.

Special loads not included in the code-required live loads are also noted in the table that
includes the live loads. Examples of such loads are architectural features, partition live loads,
ceiling and hanging loads, and super-imposed dead loads. A diagram may be needed for heavy
pieces of equipment, such as forklifts, with their assumed wheel spacing and axle loads.

Showing the self-weight of the structure is not a requirement of the code. However, the
cement density should be provided on the drawings so that the self-weight of the structure can
be accurately determined by the formwork engineer.

3.4.1.3 Specifications

The first concrete general note is commonly a reference to require construction to be in
accordance with ACI 301 “Specifications for Structural Concrete”. The licensed design
professional (LDP) ensures that the construction documents meet code provisions; therefore,
requiring the contractor to conform to ACI 318 is not appropriate as it provides code
requirements to the LDP and not the contractor or materials supplier. By incorporating ACI 301
by reference into the construction documents and using the ACI 301 mandatory and optional
checklists, the concrete materials and construction requirements will satisfy ACI 318. In addition
ACI 301 also specifies that fabrication and construction tolerances shall comply with ACI 117
“Specifications for Tolerances for Concrete Construction and Materials”.

ACI 301 contains the following three checklists: mandatory, optional requirements, and
submittals. The LDP is often also the Specifier on a project and must go through these checklists
and make necessary exceptions to ACI 301 in the construction documents. The general notes
sheet is a convenient way to communicate any necessary exceptions to ACI 301.

3.4.1.4 Concrete notes

ACI 301 Mandatory Requirements Checklist items related to concrete can be specified in
the general concrete notes and indicate that the construction documents include:
- Exposure class and specified compressive strength $f'_c$ for different elements
- Handling, placing and constructing requirements
- Designations and requirements for architectural concrete, lightweight concrete, mass
  concrete, post-tensioned concrete, shrinkage-compensating concrete, industrial floor
  slabs, tilt-up construction and pre-cast concrete

Concrete general notes can show these with a table with each element type along with its
corresponding exposure class, specified compressive strength and other requirements.

The construction documents should also indicate any exceptions to the default requirements
of ACI 301. ACI 301 lists possible exceptions in the Optional Requirements Checklist.

Concrete general notes often contain the following optional requirements checklist exceptions to
ACI 301 default requirements:
• Air entrainment in percentage (%), along with the respective tolerance
• Slump in inches (in), along with the respective tolerance
• When high-range-water-reducing admixtures are allowed or required
• Additional testing and inspection services

When proprietary concrete products are required on a project, they can be specified in the general notes.

3.4.1.5 Reinforcement notes

ACI 301 Mandatory Requirements Checklist items related to reinforcing steel can be specified in the general reinforcement notes and indicate that the construction documents include:

• Type and grade of reinforcing bars
• Bar development and splice lengths and locations
• Types of reinforcement supports and locations used within the structure
• Specify the cover for headed shear stud reinforcement and headed reinforcing bars

The construction documents must indicate any exceptions to the default requirements of ACI 301. ACI 301 lists possible exceptions to the default requirements in the Optional Requirements Checklist. Some exceptions to ACI 301 default requirements may include the following:

• Weldability of bars
• Concrete cover to reinforcement
• Specialty item type and grade
• Coatings such as epoxy or galvanized and where applicable
Permitting field cutting of reinforcement and the cutting methods

Reinforcing bars require concrete cover to protect the steel from corrosion. ACI 301 shows concrete cover requirements for specific members in Table 3.3.2.3. The concrete cover requirements for a project are typically shown in a table or list showing the type of member, the concrete exposure, the type of reinforcement and the concrete cover requirements for each. If there are locations on a specific project that are questionable, the LDP should indicate which concrete cover requirement controls at each location (i.e. fire rated elements).

When proprietary reinforcement products are required on a project, they can be specified in the general notes.

3.4.1.5.1 ACI 318 reinforcing requirements

Reinforcing bars (rebar), spirals, strands, wires and bar mats in conformance with ASTM International specifications are accepted for construction in the United States and are required by ACI 318, “Building Code Requirements for Structural Concrete.” Type and grade of reinforcing are typically shown in a note. When there are more than one type and/or grade of reinforcing used on a project, it may be easier to show this information in a table indicating what type and grade is used in what parts of the structure. See Fig. XXXXXX

3.4.1.5.2 Development and splices

ACI 318 requires that the development length/embedment of reinforcement and location and length of lap splices be shown on the construction documents. Bar development and lap splice
lengths and locations can be shown using tables, but the preferred method for showing development and lap splice length and location is graphically in plan, elevation, section, or detail with dimensions provided. This allows the fabrication detailer to more accurately read this information from the drawings. Where lap splice location and length have structural safety implications, the lap splice lengths should be shown graphically. When engineering judgment indicates that lap splice location and length are less critical, a table can be used. Structural calculations should not be required of the fabrication detailer to determine the lap splice length or development lengths. Lap and development lengths calculated by the LDP should be shown on the design drawings. The LDP should verify that all possible bar development and lap splice length arrangements that are on the project can be found on the drawings. See Fig. XXXXXXX

If mechanical splices are permitted or required on a project, a note is needed on the general notes sheet or project specifications to permit them as well as the required ratio of bar strength to splice strength. The LDP should also include a typical detail or specific details on where mechanical splices are required or permitted. See Fig. XXXXXXX

If headed bars are permitted or required on a project, a note is needed on the general notes sheet or project specifications to permit them as well as the required bearing area, cover and embedment lengths. The LDP should also include a typical detail or specific details on where headed bars are required or permitted. See Fig. XXXXXXX

3.4.1.5.3 Supports for reinforcing bars

Before and during concrete casting, reinforcing bars should be supported and held firmly in place at the proper distance from the forms. The LDP specifies acceptable materials and corrosion
protection for reinforcing bar supports, side form spacers, and supports or spacers for other embedded structural items or specific areas. Specifications for reinforcing bar supports and spacers usually are consistent with established industry practice.

If the construction documents only state that reinforcing bars need to be accurately placed, adequately supported, and secured against displacement within permitted tolerances, the contractor selects the type and class of wire bar supports, precast blocks, composite (plastic), or other materials to use for each area.

There are three common material types of bar supports: wire bar supports, precast concrete block bar supports, and composite (plastic) bar supports. A common sub-type of wire bar supports is plastic-tipped wire bar supports which are often used when aesthetics are a concern. CRSI Standard RB4, “Supports for Reinforcement Used in Concrete” describes the various types of wire, composite and precast bar supports.

As mentioned above, certain support types can cause aesthetic issues. For example, if precast blocks are used and the surface has a sand-blasted finish, the different texture and color between the precast blocks and the cast-in-place concrete may be objectionable. Another example of aesthetic issues is that Class 3 wire bar supports may leave rust stains on the exposed concrete surfaces. The LDP and contractor should work together to help prevent these issues from occurring because repair for aesthetic issues can be costly.

Beam bolsters support bottom beam reinforcement and are placed in the beam form, usually perpendicular to the axis of the beam under the stirrups. Beams may also be supported
with individual chairs or blocks placed under the beam stirrups.

![Typical Wire Beam Bolster](image)

Bar supports are furnished for bottom bars in grade beams or slabs-on-ground only if required by the LDP in the construction documents. For a structural element, it is recommended that the LDP specify bar supports for the bottom bars in grade beams or slabs-on-ground. Aesthetics are not a concern in the bottom of a slab-on-ground or grade beam which allows the use of precast blocks for bar supports.

. Side form spacers may be specified for use, but are usually selected by the contractor.
3.4.1.5.4 Weldability of bars

The weldability of steel is established by its chemical composition. The American Welding Society AWS D1.4 sets the minimum preheat and interpass temperatures and provides the applicable welding procedures. Carbon steel bars conforming to ASTM A615/A615M may or may not be weldable when evaluated under those requirements depending upon chemical composition. Only reinforcing bars conforming to ASTM A706/A706M are pre-approved for welding reinforcing bars without preheating. Because AWS D1.4 covers only welding A615/A615M and ASTM A706/A706M bars and chemical compositions are not ordinarily meaningful for rail-and axle-steel bars, they are not recommended for welding.

3.4.1.5.5 Hooks and bends

It is standard practice in the industry to show all bar dimensions as out-to-out and consider the bar lengths as the sum of all detailed primary dimensions, including Hooks A and G. It is important to note the difference between “minimum” bend diameter and “finished” bend
diameter. "Finished" bend diameters includes a "spring back" effect when bars straighten out slightly after being bent and are slightly larger than "minimum" bend diameters.

Standard bend shapes will have not more than six bend points in one plane, bent to normal tolerances. Shapes with more than six bends, or bent to special tolerances or bent in more than one plane involve greater difficulty and are subject to added costs.

Bar hooks and bends are occasionally not shown on the drawings, but a note is placed stating that certain bars are required to end in a standard hook. Specifications that require a non-standard hook should be used with caution because non-standard hooks may be difficult to obtain. If the LDP shows a hook but does not dimension the hook, the reinforcing bar detailer will use an algorithm similar to the following Block Flow diagram to determine the proper size hook to use:

<table>
<thead>
<tr>
<th>Are hooks dimensioned on plan?</th>
<th>Yes</th>
<th>Use plan dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does a standard 90 degree hook fit?</td>
<td>Yes</td>
<td>Use a standard 90 degree hook</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does a standard 90 degree hook rotated 45 degrees fit?</td>
<td>Yes</td>
<td>Use a standard 90 degree hook rotated 45 degrees</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does a standard 180 degree hook fit?</td>
<td>Yes</td>
<td>Use a standard 180 degree hook</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does a standard 180 degree hook rotated 45 degrees fit?</td>
<td>Yes</td>
<td>Use a standard 180 degree hook rotated 45 degrees</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RFI</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
For this reason, it is prudent for the LDP to check hooks throughout the project during their constructability check suggested in chapter 8, especially if rotating the hooks causes issues with design. A standard hook only defines dimensions of the bend shape. This is not an indicator of development strength. See Fig. XXXXXX

3.4.1.5.6 Welded wire reinforcement

Welded wire reinforcement consists of a series of cold-drawn steel wires arranged at right angles to each other and electrically welded at all intersections. Welded wire reinforcement has many uses in reinforced concrete construction. It can be used in slabs-on-ground, joist and waffle slab construction, walls, pavements, box culverts and canal linings.

The general notes or the specifications will specify the welded wire reinforcement required. Welded wire reinforcement can be in the form of flat sheets normally 8 ft. 0 in. by 20 ft. 0 in. or rolls which are usually 5 ft. 0 in. by 150 ft. 0 in. The wire may be plain or deformed.

Welded wire reinforcement in conformance with ASTM International specification A1064 is accepted for construction in the United States and is required by ACI 318.

Table 1 gives common styles of welded wire reinforcement in the U.S. (inch-pound).
### Common Styles of Welded Wire Fabric

<table>
<thead>
<tr>
<th>Style Designation</th>
<th>Steel Area (in²/ft)</th>
<th>Approximate Weight (pounds per 100 sq ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Longitudinal</td>
<td>Transverse</td>
</tr>
<tr>
<td>4 x 4-W1.4 x W1.4</td>
<td>0.042</td>
<td>0.042</td>
</tr>
<tr>
<td>4 x 4-W2.0 x W2.0</td>
<td>0.060</td>
<td>0.060</td>
</tr>
<tr>
<td>4 x 4-W2.9 x W2.9</td>
<td>0.087</td>
<td>0.087</td>
</tr>
<tr>
<td>4 x 4-W/D4 x W/D4</td>
<td>0.129</td>
<td>0.129</td>
</tr>
<tr>
<td>6 x 6-W1.4 x W1.4</td>
<td>0.028</td>
<td>0.028</td>
</tr>
<tr>
<td>6 x 6-W2.0 x W2.0</td>
<td>0.040</td>
<td>0.040</td>
</tr>
<tr>
<td>6 x 6-W2.9 x W2.9</td>
<td>0.068</td>
<td>0.068</td>
</tr>
<tr>
<td>6 x 6-W/D4 x W/D4</td>
<td>0.094</td>
<td>0.094</td>
</tr>
<tr>
<td>6 x 6-W/D4 x W/D4</td>
<td>0.148</td>
<td>0.148</td>
</tr>
<tr>
<td>6 x 6-W/D4 x W/D4</td>
<td>0.150</td>
<td>0.150</td>
</tr>
<tr>
<td>6 x 6-W/D4 x W/D4</td>
<td>0.156</td>
<td>0.156</td>
</tr>
<tr>
<td>6 x 6-W/D4 x W/D4</td>
<td>0.160</td>
<td>0.160</td>
</tr>
<tr>
<td>6 x 6-W/D4 x W/D4</td>
<td>0.162</td>
<td>0.162</td>
</tr>
<tr>
<td>6 x 6-W/D4 x W/D4</td>
<td>0.166</td>
<td>0.166</td>
</tr>
<tr>
<td>12 x 12-W/D8.3 x W/D8</td>
<td>0.083</td>
<td>0.083</td>
</tr>
<tr>
<td>12 x 12-W/D8.8 x W/D8</td>
<td>0.088</td>
<td>0.088</td>
</tr>
<tr>
<td>12 x 12-W/D8 x W/D9</td>
<td>0.091</td>
<td>0.091</td>
</tr>
<tr>
<td>12 x 12-W/D9.4 x W/D9</td>
<td>0.093</td>
<td>0.093</td>
</tr>
<tr>
<td>12 x 12-W/D16 x W/D16</td>
<td>0.160</td>
<td>0.160</td>
</tr>
<tr>
<td>12 x 12-W/D16.6 x W/D16</td>
<td>0.166</td>
<td>0.166</td>
</tr>
</tbody>
</table>

*Many styles may be obtained in rolls.

### 3.4.1.6 Construction notes

Construction notes are general notes that discuss many of the miscellaneous aspects of construction not covered by the other types of notes. Some examples of these notes include information regarding:

- what the contractor should do if there are discrepancies between field conditions and the construction drawings
- shoring and bracing

We need a clean schedule here.
• excavation rules
• relationships between other trades and the structural drawings
• backfill
• safety
• permit
• coordination of trades
• general inspection requirements
• final building characteristics

3.4.1.7 Inspection notes

The general note sheet should indicate the level of inspection required for the project. If the structure includes members that require special inspection, such as a special seismic force resisting system, they should be identified on the general note sheets. See Fig. XXXXXXX

3.4.2 Plan sheets

Section 1603.1 in the 2012 IBC states: “Construction documents shall show the size, section, and relative locations of structural members with floor levels, column centers, and offsets dimensioned.” A plan drawing provides information about an identified building floor, including overall geometry and dimensions, concrete member width and thicknesses (either directly or by a designation keyed to a schedule), and reinforcement information for concrete members (either directly or by a designation keyed to a schedule). A plan drawing can include a general reference to other sheets, such as an elevation sheet or a detail sheet. A floor plan also includes orientation information, such as column line numbers, a north arrow, top of concrete relative to a datum, and general notes specific to the floor plan.
Member reinforcement such as beams can be directly shown on the plan or indirectly provided through use of schedule marks, such as beam numbers. Plan drawings are usually drawn to 1/16 or 1/8 inch scale. For small floor plans larger scales may be used. The primary consideration for scale to be used is the complexity of the plan. Clarity should be maintained by using a larger scale if a large amount of information needs to be conveyed in a small area of the plan. If the designer needs to break up the plan into several parts for a floor, they should take into account portions of the structure, assumed placement sequences, or some other easily readable way of breaking the plan into smaller pieces.

Because plans only provide information in the horizontal direction, sectional views, also known as cuts, are needed to clarify geometric and reinforcement information in the vertical direction. A sectional view is indicated by a directional mark or cut drawn on the floor plan. 

3.4.2.1 Plan graphics and member geometry

The assumed viewpoint for a plan drawing is above the slab on each floor level of a structure. Therefore, slab edges are usually shown as solid lines on the plan drawings. Beam and girder locations are typically shown as hidden on the plan drawings because they are typically below the slab. See Fig. XXXXXXX

Columns and walls that are shown solid extend above the slab on the plan. These vertical members of the structure will be shown on all of the plans from their lowest elevation in the structure, usually the foundation but occasionally a transfer girder or slab, to their highest elevation in the structure, usually the top tier where they will be drawn as hidden.

Foundations are drawn as hidden when they are below the slab on grade and solid when not covered by structural members or slab on grade concrete. Soil is not considered a structural
member for this purpose. Slabs, beams, girders, columns, walls, and foundations are sometimes
given schedule marks on the plan drawings to indicate the type of member, size of concrete
member, and reinforcement required. See Fig. XXXXXX

3.4.2.2 Reinforcement on plan views

Reinforcement that is not typical, such as slab reinforcement required where a varied
column layout or a large slab opening occurs, is often shown on the plan drawings instead of
using slab marks. See Fig. XXXXXX

When the amount of slab reinforcement being shown on a plan drawing becomes so large
that the plan is difficult to read, it is acceptable to make additional plans. These additional plan
sheets can be used so that one shows the bottom reinforcement, one shows the top reinforcement,
and another that shows additional steel such as that required around openings and should be
properly labeled. Additional beam and girder reinforcement is not typically shown on the plan
drawings because it can cause confusion. If additional reinforcement is required for beams and
girders, it is typically shown in a note or remark in the beam schedule and a corresponding detail
or section cut will be provided to show the additional reinforcement.

3.4.3 Elevation sheets

An elevation sheet contains drawing information about identified concrete members from
an elevation view. Elevation drawings do not require a set scale, so an appropriate scale is
chosen based on the height of the elevation being drawn and the level of detail needed. Similar
to plan drawings, the scale is often based on the complexity of the structure and the elevation can
be split into several drawings as required to show enough detail. See Fig. XXXXXXX

The elevation drawing provides orientation information, such as column lines or floor
levels, and is connected to the plan drawings by noted concrete elevations relative to a datum,
section references, and orientation information.

An elevation drawing that provides member dimensions can also provide member
reinforcement. This information can be provided directly or by a designation referenced to a
schedule.

When beams, columns, walls, or all are part of a seismic lateral load resisting system,
elevations are often used to show all of the reinforcement in the members that are part of that
system. Ordinary moment frames, intermediate moment frames, and special moment frames and
shearwalls all have seismic detail requirements in ACI 318. See Fig. XXXXXXX

3.4.4 Section sheets

A section sheet is used for most projects. Sometimes, a single sheet combines sections,
details (3.4.6), and schedules (3.4.7). Most sections are drawn at 3/4 inch scale but larger scales
may be used, if more detail is needed for clarity. Sections are usually drawn from a point of view
perpendicular to that of the drawing that calls out for the section, and is oriented by pointers on
the section call out. A sectional view will show the geometry and reinforcement details at the cut
plane, and may be drawn on a plan sheet, a sections sheet, or on a details sheet. The cut identifies
the section number and the sheet number where the section is drawn. See Fig. XXXXXXX

3.4.5 Large scale view sheets
Large scale views are used if a dramatically increased scale of a section or detail is needed to show additional clarity in an area of a structure. They are used to clarify reinforcement detailing in an unusual element, such as a curved stair case, complex elevator core, or heavily reinforced link beam. These sheets are rarely titled "large scale views" but are usually titled by what is being shown on the sheet. For example, "Stairs – Plans and Sections" could be an example title for a large scale view sheet for a stair tower. See Fig. XXXXXXX

3.4.6 Detail sheets

Details are usually drawn from the same point of view as the drawing that calls out the detail. See Fig. XXXXXXX

A separate detail sheet is usually used on a project. However, small projects may have a single sheet that combines sections (3.4.4), details, and schedules (3.4.7).

Many details are drawn at 1/2 inch to 1 inch scales, but larger scales are used if needed for clarity. In heavily congested areas, using full scale drawings is suggested to help with checking constructability. <a couple of figures will be helpful to show this>

Details that are applicable to commonly encountered conditions are usually placed on “typical details” sheets. Often the typical details are schematic only and are not drawn exactly. When the typical details are schematic only, the information regarding the detail is shown in a separate table or given in the notes. If not, it is typically shown just as an example of what needs to be done and the contractor has some freedom to choose the best means and methods for building the detailed item as shown.

For example, trim reinforcement around a slab or wall opening is often standard for a certain range of opening sizes, and this arrangement is shown in a typical detail. This allows the contractor to trim any opening within the stated range without asking the engineer for a specific
solution. Other typical details include reinforcement around an in-slab conduit, a mechanical chase through a concrete slab, openings through a beam, reinforcement termination details at edges of concrete, contraction joints in slab-on-ground, and construction joints.

Bundling bar details for splice and special development lengths that affect many different types of members, such as heavily reinforced slabs, beams, columns, and walls is best shown in a typical detail on the respective member schedule sheet because the information is member specific and should be shown in the typical details sheets. See Fig. XXXXXX

Shear reinforcement in a one-way slab is rarely used, but if it is, the shear reinforcement area is typically shaded or hatched on the plan drawing. A detail should be included and sometimes on the slab schedule sheet to indicate bar size, spacing of shear reinforcement, and shape of bent bar. Headed shear studs may also be a viable option and a detail should be drawn if chosen. See Fig. XXXXXX

3.4.7 Schedule and Diagram Sheets

Schedule sheets provide reinforcement information for various members, such as slabs, beams, columns walls and foundations. A diagram to explain the information in the schedule is usually provided. See Fig. XXXXXX

Member schedules usually contain the following:

- Member mark which should have a standard naming convention and be identified on plans an elevations
- Member dimensions
- Member reinforcement
• Remarks or notes describing atypical reinforcement patterns, elevation, concrete strength etc.

3.4.7.1 Slab Schedules

Slab schedules usually contain the slab mark, thickness of slab, bottom reinforcement and top reinforcement, and any notes or remarks necessary for that slab. See Fig. XXXXXXX

For one-way slabs, the LDP can use the termination rules to use material more efficiently. Please see Figure X.XX for example details.

Two-way slabs supported by edge walls or by edge-beams require reinforcement in the top and the bottom of the slab at the intersection of the two-way slab and edge members. This reinforcement is shown using typical details if it occurs throughout the structure or the information is shown right on the plan drawings if it is not a prevalent detail. Please see Figure X.XX for example details.

Two-way slab structural integrity reinforcement requirements can be shown in different ways. The splicing requirements for structural integrity reinforcement can be shown on the slab schedule diagram. The requirement of two column strip bottom bars or wires that are required to go through the columns can also be shown on the plan or in a typical detail. The typical detail option is probably used most often because other information can be shown on the same detail if the designer wishes. When using shearheads, the two column strip bottom bars or wires should be shown in a typical detail. Please see Figure X.XX for example details.

Two-way shear reinforcement in slabs could be headed shear studs, typical stirrups, or structural steel members. Headed shear studs are used most often and a detail should be drawn to show the layout of the headed shear studs especially at a column. When several different layouts
of headed shear studs are needed in a structure, it may be clearer to use a series of headed shear stud diagrams, possibly in a table, to show their layouts as they vary throughout the structure. The plan drawings should be marked at each column to indicate which particular headed shear stud diagram should be used at that location. While stirrups are not used as regularly as headed shear studs for two-way shear reinforcement, they are permitted by the ACI 318 Code. When stirrups are used for two-way shear reinforcement, they should be shown using the methods described above for showing headed shear studs. Structural steel members are rarely used and if used their locations should be identified and special details provided. See Fig. XXXXXXX

3.4.7.2 Beam and girder schedules

Beams and girders are often shown in the same schedule and the information presented is similar. For simplicity of wording, the term beam and beam schedule will be used here to include both. Beam schedules contain the beam mark, beam width and depth, top and bottom reinforcement and extent, post-tensioning reinforcement when applicable, and stirrup size and spacing. See Fig. XXXXXXX Along with the beam schedule, there should be a diagram to show the basic layout of the reinforcing steel in a beam. For clarity, this often requires two diagrams with one showing the longitudinal reinforcing steel and the other showing the shear reinforcing steel. The diagrams are often split into the following different types of beams: single span, multiple spans, and cantilever.

When applicable, the post-tensioning is typically specified using the assumed effective force that is expected to be applied to the beam or using the number of tendons from the design. . Typical shear reinforcing stirrup sizes and spacing are shown in the schedule by specifying each group of stirrups. For example, a beam may need 6-#4 stirrups at 2"o.c. and then 6-#4 stirrups at 6"o.c. at each beam end and the remainder along the length of the beam at 12" o.c.
Often, this type of shear reinforcement spacing at the ends of the beams or at other special shear reinforcing locations is shown in a typical diagram on the beam schedule sheet. The LDP should provide a detail of stirrups showing the shape of the stirrup.

3.4.7.3 Column schedules

Column schedules usually contain the column mark, a vertical reinforcement, and the size and spacing of shear reinforcement. See Fig. XXXXXXX Along with the column schedule, typical layout information for the column reinforcement from the bottom of one level to the bottom of the next or the top of the column is often shown in section cuts or diagrams. These diagrams should show splice locations, including locations of staggered splices and reinforcement termination requirements. Often, the spacing of the shear reinforcement at the tops and bottoms of columns varies and is shown in a typical diagram on the column schedule sheet. If applicable, the following diagrams also should be included with the column schedule: basic transition from floor to floor, offset transitions, sloped transitions, and top of column terminations.

3.4.7.4 Wall schedules

Wall schedules usually contain the wall mark and the amount of vertical and horizontal reinforcement for each curtain of reinforcement required. Along with the wall schedule, typically there will be a diagram of the wall from the bottom of the wall to the top of the wall sometimes with section cuts showing the layout information for the wall reinforcement. These diagrams should show splice locations, including locations of staggered splices if necessary. Placing location of the reinforcement should be clearly shown, such as VEF, HIF, HOF, caps, etc. See Fig. XXXXXXX See Chapter 2 for other abbreviations.

3.4.8 Foundation sheets and schedules
Foundations are sometimes treated separately from the remainder of the structural systems because of their unique characteristics and in general, the fact that foundation systems are used for many various superstructure types. Foundation drawings may be issued separately from the superstructure drawings or may be the only reinforced concrete drawings on a project. Foundation sheets are commonly used for shallow foundations such as strip footings, isolated footings, combined footings, mat foundations and grade beams or for deep foundation systems that may include pile caps, piles, drilled piers and caissons. See Figures XXXXXX.

Foundation drawings can be individualized or used with schedules and foundation marks used to represent the foundation type are usually identified by the first letter of the foundation member represented. For example, P1 is usually related to a pile cap over piles, while F1 is often used to describe a shallow footing and GB1 is often used to mark grade beams. In any case, it is recommended that an Abbreviation and Notation Legend be included in the drawing sheet for clarity and ease of identification. Grade beam schedules are similar to elevated beam schedules and guidelines regarding beam schedules are shown in 3.4.7.2. Pile cap schedules should include the dimensions of the pile cap and the required reinforcement in each one. Footing schedules are usually similar, with the schedule containing footing dimensions and the required reinforcement in each direction. Drilled piers are often not scheduled by mark, but by shaft and bell diameters. The schedule should include a listing of vertical reinforcement, tie reinforcement, and minimum distance that the reinforcement must extend into the top of the pier. See Fig. XXXXXXX.

Each different type of foundation element on the project should have a corresponding typical diagram that is referenced from the schedule. This typical diagram will show a typical layout of the member with typical locations of the reinforcement inside of it. See Fig. XXXXXXX.
Shear reinforcement in a foundation is not frequently used, but when it is, it is typically detailed in a manner similar to a beam. When stirrups are used for shear reinforcement, they should be shown on the foundation schedule and a separate detail or section should be considered.

3.4.9 User defined

User defined sheets are used to show information that is not presented on other sheets, List of examples needed.

3.4.10 3D Representations

3D representations, or isometric sketches are not commonly used but can be very helpful to show an especially complicated connection or joint or to coordinate among different disciplines to prevent clashes between different systems. (Sample needed.)
CHAPTER 4 – PLACING DRAWINGS

4.1 – Definition

Placing drawings are working documents that show the quantity, bar size, dimensions and location of reinforcing steel as required for fabrication and placement. Placing drawings may comprise plans, details, elevations, schedules, material lists, and bending details. They can be prepared manually or by computer.

4.2 – Scope

Placing drawings convey the LDP’s design intent as covered in the contract documents in order to assure proper fabrication and placement of reinforcing steel. The contract documents plus addenda issued by the LDP (per terms agreed upon in the contract if issued after the contract is made), constitute the sole authority for information in placing drawings. Because no new design intent is added during the creation of placing drawings, they do not require and engineer’s seal. The LDP must furnish a clear statement of the design requirements in either the project specifications or structural drawings and may not refer to an applicable building code or other codes for information necessary to prepare the placing drawings. Such information must be provided by the LDP in the form of specific design details or notes.

Necessary additional information such as field conditions, field measurements, construction joints, and sequence of placing concrete must be supplied by the contractor. After approval by the LDP, including necessary revisions, the drawings may be used for fabrication and placing of reinforcing steel.
4.3 – Procedure

Placing drawings are most commonly prepared by a detailer, typically employed or contracted by the reinforcing steel fabricator. General steps for producing and utilizing placing drawings are as follows:

1. Detailer prepares placing drawings based on information found on the project specifications and structural drawings as well as information related to construction requirements obtained from the contractor.

2. Placing drawings are submitted to the contractor or his designee for review and approval.

3. Once placing drawings have been approved, releases are prepared from the bar lists on the placing drawings, based upon a delivery sequence agreed upon between the fabricator and the contractor.

4. Releases are submitted for fabrication in accordance with the current delivery schedule.

5. Reinforcing steel is cut, bent, tagged, bundled and delivered to the job site along with other material, such as bar supports, as specified in the contract.

6. Reinforcing steel is installed based on details found on the placing drawings and in accordance with specifications found throughout the contract documents.

4.4 – References

The information found in this section is intended to provide a general overview of the definition, purpose and use of reinforcing steel placing drawings. For more specific information and guidelines please refer to the Detailing section of the “CRSI Manual of Standard Practice”. Additionally, for a better understanding of the fundamentals and best practices in the preparation of reinforced concrete placing drawings please refer to the “CRSI Reinforcing Bar Detailing Handbook”.
Chapter 5 – Reviewing Placing Drawings

1.0 Purpose of Review

In some areas of North America, review of placing drawings by the Contractor and LDP is not required and is rarely done. LDP’s in these areas take the view that since their inspection of installed rebar is made using their contract design drawings, placing drawings serve no purpose in the inspection process and therefore require no review. Errors are picked up and corrected at inspection time. The downside to this approach is that correcting errors in the field can cause delays and increase costs.

For this reason, most areas of North America encourage review of placing drawings by the Contractor and LDP. Review is deemed to have a number of worthwhile benefits such as:

- tends to include the LDP as part of the team effort
- verifies conformance with general design intent
- verifies that the most recent revised contract drawings have been used
- catches and corrects small errors or omissions that would otherwise delay the project if left to be discovered during inspection in the field
- provides an opportunity for the LDP to make small changes or corrections to the design “on the fly”
- provides assurance to the detailer that he understands the design concepts and is proceeding correctly
- reviewed placing drawings form a large part of the “As Built” documents package

Most project specifications allow the LDP a given period of time to make his review, in most cases two weeks. The detailer and construction team factor this review time into their schedules. It is therefore important for the LDP to work within this constraint to help keep the project on schedule.
2.0 Review process

Ideally the process for submission and review of placing drawings should be outlined in the contract documents. The process varies from project to project but generally will include the following steps:

- Detailer submits the placing drawings to the contractor or his designee
- The contractor or his designee reviews the drawings and forwards them to the LDP
- The LDP completes his review and returns the drawings to the contractor in a timely manner
- The reviewed drawings are returned to the detailer
- The detailer makes all necessary amendments and either resubmits if required, or authorizes the detailed rebar for fabrication

3.0 Check List for Review of Placing Drawings

Each LDP will have his own check list but generally will include at least the following items:

- Verify latest issue of contract drawings
- Verify latest issue of addenda and supplementary documents such as RFI’s, DCN’s, and FCN’s
- Verify grades, coatings, and sizes of rebar
- Verify that all rebar has been included and properly located

4.0 Levels of Approval

There are many variations of approval levels. Each LDP usually develops one that suits his requirements. Most will include as a minimum the following items:

- *Approved* - these drawings meet all design requirements and are approved for fabrication and installation.
• **Approved as Noted** – these drawings require small corrections that do not impact the design intent. Once corrections are completed they are approved for fabrication and installation. Resubmittal is not required.

• **Revise and Resubmit** – these drawings have significant errors that impact the design intent. The LDP must review them again before he can approve them. Resubmittal is required.

• **Not Approved** – These drawings do not meet the design intent. Alternately, perhaps, the LDP is aware that new or revised design documents are about to be issued that will supersede previous contract drawings. In either case completely new detailing is required and submitted.

It must be noted that by approving rebar placing drawings for fabrication and installation, the LDP does not incur any responsibility for delays and costs associated with errors or omissions on those drawings. These delays and costs remain the responsibility of the contractor, fabricator, and the placer.
CHAPTER 6—TOLERANCES

5.1 ACI 117

ACI 301, "Specifications for Structural Concrete" requires that construction tolerances comply with ACI 117 "Specifications for Tolerances for Concrete Construction and Materials." ACI 117 provides tolerances that are standard for concrete construction, including tolerances for reinforcing bar fabrication and placement. Placing tolerances have an effect on cover, strength, constructability, and serviceability. If more restrictive tolerances are required than those shown in ACI 117, they need to be indicated in the construction documents.

In areas of potential congestion the LDP must consider combinations of tolerances. Certain combinations of tolerances can result in conflicts that are not simple to remedy in the field. For instance, the “+” tolerance for a bent bar may cause the bar to encroach into the concrete cover and exceed the “-” tolerance for that cover.

The design/construction team must identify and remove conflicts prior to construction.
CHAPTER 7 – DETAILING ISSUES FOR THE DESIGNER

This is a chapter in the new guide being prepared by ACI Committee 315. The guide is tentatively called, “ACI Designer’s Guide to Reinforcing Bar Detailing”.

The purpose of this guide is not to teach the designer to detail reinforcing steel or to show him what good detailing looks like. Instead, this guide is to show the designer what information is required in his design documents to accurately convey his design intent to the detailer.

Following are a number issues that we feel will be of interest to the Designer. ACI Committee 315 is asking for your help in adding to the discussion of these issues. In addition to expending the text, we will be looking for descriptive sketches, diagrams, and photos.

The general format for each issue will be along the line of:
- “Issue” is frequently encountered during the construction process
- “These” are the common root causes
- “These” are the common-practice solutions

The point is to introduce the issue, discuss it, and offer a solution. We do not want the solution to appear as an instruction or demand. Hopefully the designer will pick up the message and design accordingly.

1. Minimum clearances between bars: define by measurement only. Do not define by bar diameters or aggregate size. The designer knows the bar size and the aggregate size, so state the dimension. This is another case where the detailer is asked to make a calculation and in order for the designer to check that it is correct he has to make the same calculation. It is far simpler if he makes the calculation first and puts it on the drawing. That way there is no question about accuracy. It may speed up reviews.

2. Define clear concrete cover in inches/millimeters. Do not as define as a figure for a corrosive environment, or non-corrosive environment, or by soil type. It is not the responsibility of a detailer to make a judgement on types of environment or soil type. This also applies to clearance for fire ratings. Show the clearance on the drawing for fire-rated members.
3. Provide a simple table to indicate clear cover for each concrete element, i.e. bottom; top; side of beams; inside or outside face of walls; painted exposed surfaces, etc.

4. Clearly indicate orientation of bars/stirrups in elements that are skewed to each other, i.e. bridge girders skewed to pier caps. Show arrangement of arrayed bars.

5. Clearly indicate in which concrete elements bar splices must be staggered. Provide a sketch to show the nature and length of the stagger. This is very important, especially for verticals. It is never clear if laps must be staggered at the footing.

6. Clearly indicate the length of non-standard hooks. Never show a longer than standard hook on the drawings with dimensioning it.

7. Clearly indicate at termination of vertical bars whether the bars are straight, hooked, or finished with terminators. Indicate how to terminate bars where the depth of the slab is insufficient to accommodate a hook.

8. Indicate with a sketch exactly what is the hooked bar development length. Many reviewers and inspectors confuse this length with the length of the hook, rather than the total embedment length (LDH).

9. When open or capped stirrups are acceptable in a member, indicate these as the first alternate, rather than a closed stirrup.

Expanded version:

*Beam schedules and details usually indicate closed stirrups. For large beams with long spans and heavy reinforcement, closed stirrups may reduce constructability. The long bars must be threaded into the beams through column verticals and other obstructions. With open stirrups the long bars are simply lifted and dropped into place without any threading necessary. This significantly reduces the labor cost of installation. Once the bars are installed the stirrups may be capped as necessary.*

*If closed stirrups are the only option shown on the design documents the detailer must issue an RFI requesting a change of stirrup configuration to open/capped style. This process may delay the detailer days or even weeks depending on the turn-around time for*
RFI's. This is usually an unnecessary interruption since in most cases the open/capped tie option is approved.

Design documents that clearly show both options whenever open ties are acceptable speeds up the detailing process and reduces the document flow required by the designer, contractor, and detailer. Constructability is enhanced while at the same time costs are reduced.

10. In multi-leg beam ties provide a longitudinal bar arrangement that places a continuous bar in every corner or leg of the tie set. Top and bottom extra bars can then be evenly distributed across the beam.

11. Show arrangement of verticals and ties in multi-piece tie sets. Indicate if combi-ties are acceptable.

12. In vertical elements (columns, boundary elements, walls) provide sketches of all transitions of dimensions or number of bars from one floor to the next.

13. In moment frame design where columns verticals lap at mid-height, sketches of the transitions of dimension and number of bars is absolutely necessary.

14. Provide typical details for footing and beam steps. Provide special details wherever typical details cannot be applied.

15. Provide sketches for wall corners and intersections for single and multiple layer members. Provide special details wherever typical details cannot be applied.

16. Clearly indicate layering of bars at intersecting beams and girders. Consider making the depth of beams in one direction a couple of inches deeper than the crossing beams.

17. Give thought to clearances and layering of slab top steel over intersecting beams. Indicate sequence of placing bars.
18. Typical trim bars details in the general notes frequently do not apply to large or odd-shaped openings, or openings near the soffit of a slab. Provide clear details of trim bars around all such openings, especially in complex layering of rebar.

19. Clearly indicate bar arrangement for slab depressions, especially in areas of dense reinforcement.

20. In deep foundations that require skin reinforcing on the sides, use vertical U-bars around the perimeter rather than putting long hooks on bottom and top bars. If long hooks are required on the bottom and top bars, provide a sketch to show how they are to be spliced. Do not simply show the bottom bar hooks rising to the top of the member and the top bar hooks falling to the bottom of the member.

21. Always cloud ALL changes on revised drawings. Alternatively provide a numbered delta at each revision. Never cloud or delta some changes but not others.

22. Do not provide lap lengths as multipliers of bar sizes. Provide a proper table showing dimensioned laps for ONLY the concrete strengths found in the project. Do not pull a huge table from some extraneous manual.

23. Designer must think about the lap lengths he is calling out. For instance do not call for 11'-4" laps on #11 boundary elements verticals when the floor to floor height is only 10"-0".

24. For spirals, indicate number of turns at bottom and top; are 135° hooks required; nature of laps (i.e. simply lapped, lapped with hooks, welded, coupled); sketch to show varying spacing.

25. For hoops, show simple lap or lap with hooks; show number of bars to be included between hooks.
26. Select proper coupler type to suit the situation. I.e. Barlock is too big for columns and boundary elements. Some fit well between ties for columns and boundary elements.

27. Issues with congestion with hooks or terminators at intersecting members.

28. Issues with stud rails, etc.

29. Issues with construction and expansion joints.

30. Issues with conflicts between reinforcing and water stops.

31. Cold and heat bending of embedded bars.

32. Issues regarding cutting bars in the field, especially with a cutting torch.

33. Caution with mixing different grades of bars on a single project.

34. And so on. This list should probably be at least twice as long.

Thank you for your help.
CHAPTER 9—REFERENCES

10.1—Reference standards and reports

The standards and reports listed below were the latest editions at the time this document was prepared. Because these documents are revised frequently, the reader is advised to contact the proper sponsoring group if it is desired to refer to the latest version.

American Concrete Institute (ACI)
117-10—Specification for Tolerances for Concrete Construction and Materials
132-14—Guide for Responsibility in Concrete Construction
301-10—Specifications for Structural Concrete
318-14—Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary

American Society of Civil Engineers (ASCE)
7-10—Minimum Design Loads for Buildings and Other Structures

American Welding Society (AWS)

ASTM International
A615/A615M-15-Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
A706/A706M-14—Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
A1064/A1064M-14—Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

Concrete Reinforcing Steel Institute (CRSI)
Reinforcing Bar Detailing, 2015
Manual of Standard Practice, 2009
RB4-2014—Standard for Supports for Reinforcement Used in Concrete

International Code Council (ICC)
2012 IBC—International Building Code

National Institute of Building Sciences (NIBS)
United States National CAD Standard, V6

Authored Documents
Reinforcing Bars: Anchorages and Splices, 2008, fifth edition, Concrete Reinforcing Steel Institute, Schaumburg, IL