

July 18, 2014 Update Notes

The July 18, 2014 update to ODOT's CADD standards includes five new rebar shapes added to ODOT_Bridge.cel. The following cells have been added:

Cell Name
REBAR22
REBAR23
REBAR34
REBAR35
REBAR36

Support for these five new rebar shapes has been added to ODOT_BarInfo.mvba.

No future development is planned for this application. It is ODOT's intent to replace this application using Excel tables linked to MicroStation. If new rebar shapes are added in the future, this application will be retired. It is advised that users develop their own replacement method using Excel tables linked to MicroStation to build these rebar tables.

INTRODUCTION

Purpose

The ODOT C.O. Office of CADD and Mapping Services authorized this development effort with the end intent of having a more efficient process for drawing and filling out rebar summary charts than with our present practices, which are essentially manual. The following objectives were identified:

- To provide standardized charts to be used with the rebar summaries in order to have the consistent spacing/formatting that computerized text placement requires.
- To provide windows-like user interfaces *within* MicroStation that will:
 - (1) allow the user to enter information for standard ODOT bar shapes, straight bar, or non-standard bar shapes;
 - (2) perform complete computations for standard bars, including deducts and additions, and at least total weight computations for non-standard shapes and straight bars, and;
 - (3) provide the completed information as a line of MicroStation text, correctly formatted for a standard bar chart.

Contents

The following pages present the work done to meet these objectives, starting with a look at the standardized cells that have been made for the bar charts, continuing with a "how to use it" overview of the user interface software, then a listing of known problems/caveats and any work-arounds we have for them, and finishing with a brief mention of where the development might

go in the future. An appendix explaining the methods by which adjustments are computed is also included.

STANDARDIZING THE CHARTS

Current Practice

The Bridge design section traditionally used a fairly standard chart drawing style/format. The information in the chart had a consistent layout, with the only variation being the number of columns used to show number of bars. To maintain the consistency of the chart's appearance from plan to plan, or amongst different structures/sheets of the same plan set, the typical practice had been to copy the chart from another dgn file, remove the existing text from its rows and columns, and then fill it in again with the current structural element's bar info.

Standardized Bar Chart Cells

Because previous ODOT standard practice was to use charts that had consistent vertical and horizontal spacing formats, with the only variation being the number of columns used to show the breakdown of the number of bars, making cells for the charts appeared to be a rather effective, straightforward means of improving the standardization of bar chart formats while offering the users some possible drawing-time savings.

The cells were made for the most likely arrangement of "number of bars" columns – a cell for 1 number column (total column only), a cell for 3 columns (the number of bars for each of two structural elements or each of two phases of a structural element, and a total column), a cell for 5 columns (e.g. two piers, 2 phases, and a total column) and one for seven columns.

The new cells are all based upon charts that had typically been used for ODOT bar information, with a certain amount of "clean-up" drawing, of course. Column spacings have not been changed, and the row spacing is the same. The level was been changed from the V7 numeric level to the named level BR_P_Gen_Text.

An example of the new cells is as shown (3 number column version):

THE BAR INFORMATION SOFTWARE

Overview

The initial development software, `barInfo.mvba` (`ODOT_barInfo.mvba` as of January 2009), meets the minimum objectives for the software via a system of three user-interface windows. The first form is the "main", or controlling form. From it, the user selects from two options for the next bar to compute/place. The user's selection will bring up one of the two second-tier forms. One is for ODOT standard rebar shapes, and the other is for straight bar and custom shapes.

The form for the ODOT standard rebar allows the user to select a standard shape for which the program will compute adjustments and total weights based upon user input of the base information -- mark, bar size, total number of bars (or number of bars per series and total number of series -- and the dimensional information that is needed for the shape. It provides a display of the computed values for adjusted length per bar, total adjusted length, total adjustments, and the total weight. The computations and display provide "min and max" values for series bar. Lastly, the user can have the program make a line of MicroStation text for the bar chart. The text will be spaced according to user input on which chart is being used.

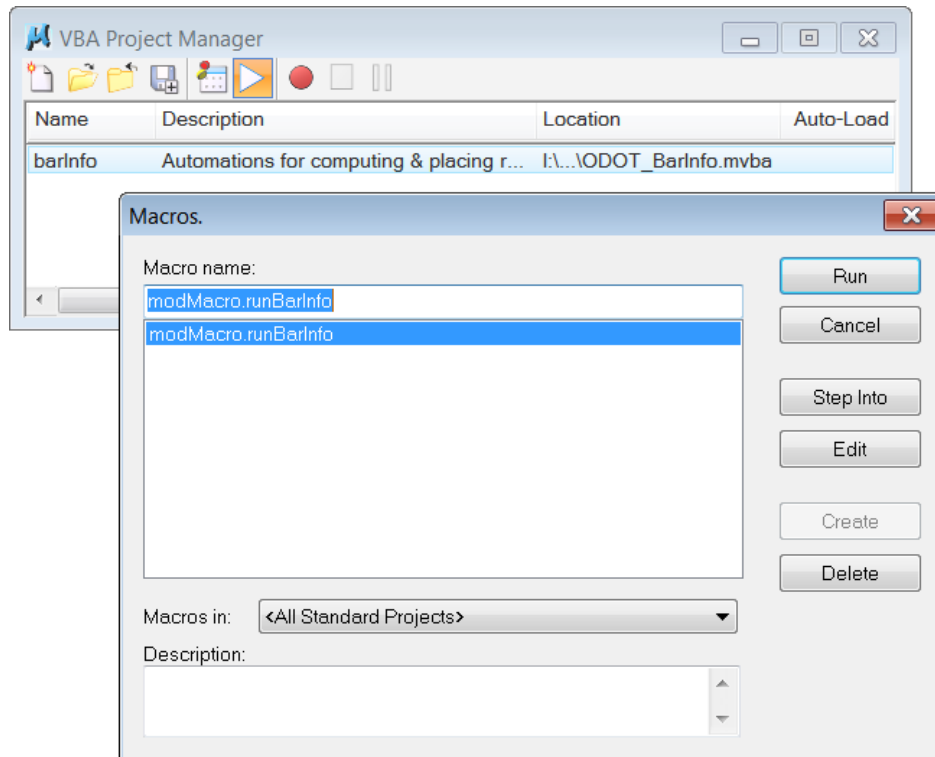
The "straight and custom shape bar" form requires the user to input the same base as well as length per bar information (min and max required for series bar). Dimensional information for bent bar is to be entered, at least if the user wants it to be included in the text for the chart. Because the program is "dumb" about custom shapes, it cannot provide adjustments -- if the user wants adjustments, he/she must compute them and enter adjusted lengths in the length per bar fields. The program does compute total weight and total length based upon the user's base and length input. Again, min and max values are displayed for series bar. MicroStation text for the bar chart may also be created from this form.

Starting the Program

The interface software is included in the ODOTApps menu.

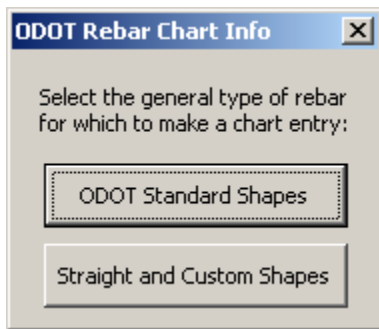
Alternatively, then, the user may run it from the MicroStation Macro Project Manager. Select Utilities>Macro>Project Manager from the MicroStation menu bar to bring up the Project Manager interface.

The interface will come up with a program named Default showing in its window. If you wish, you may select this file and close it. Next, select the open file icon on the Manager's menu bar, go to your **ODOTStd** directory, navigate to subdirectory `\vba\`, then select program **ODOT_BarInfo.mvba**. This program should appear in the Macro Project Manager's window with the name **barInfo**. Highlight it, then click the "macro" button, also on the Manager's menu bar, which will bring up a window listing the routines in the program that the Manager thinks are macros. Select "**modMacro.runBarInfo**" from the list, then Click the **Run** button:



The software's Main form will now appear on the screen.

The Main Form



As you probably gathered in the overview, this form is relatively simple; the user merely has to select the type of bar for which he/she wishes to create a bar chart entry. If you want one of the 33 standard ODOT bar shapes, select the top button. Otherwise, select the bottom button.

Standard Bar, Series

Step 1: Select the ODOT standard bar number you wish to compute and place. Its cell will be displayed in the form's picture box.

Step 2: Enter the mark number. If the mark format follows ODOT standard, the bar size should set automatically (if not, it may be set manually).

Step 3: Make sure the Series Bar check box is on.
Step 4: Enter the number of bars per series.


Step 5: Enter, in decimal feet, the minimum and maximum size of each dimension shown in the cell for the bar. It is not necessary to enter max size for those dimensions whose sizes to not vary; the program will fill them in during computation.

Step 6: Enter the total number of bars per set.
Step 7: Click the Compute button.

Step 8: Check to see that the results of the computation make sense. Also, the program will notify you of any per-bar dimension increments that are less than 1".

Step 9: Indicate which standard bar chart cell you are using.

Step 10: Click the Place Text button...

 *1 SR 3'-4" 2'-5"*
CF TU 0.1 1'-0" TU 0'-1 1/4"
11 4'-4" 3'-8"

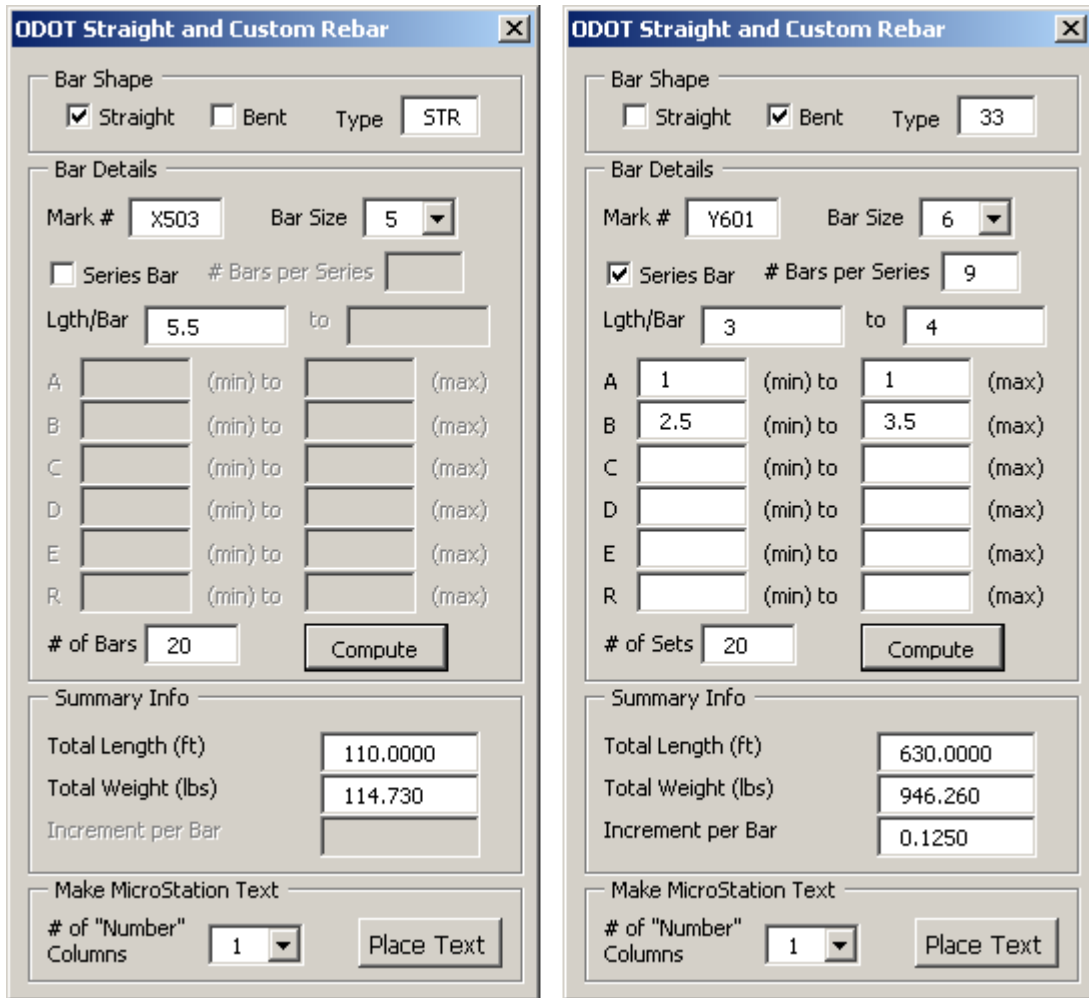
The bar information will now appear on the cursor, in feet-inches format, ready for placement in the bar chart.

The Form for Straight Bar and Custom Shapes

This form looks and works very much like that for the standard bar shapes. The differences include:

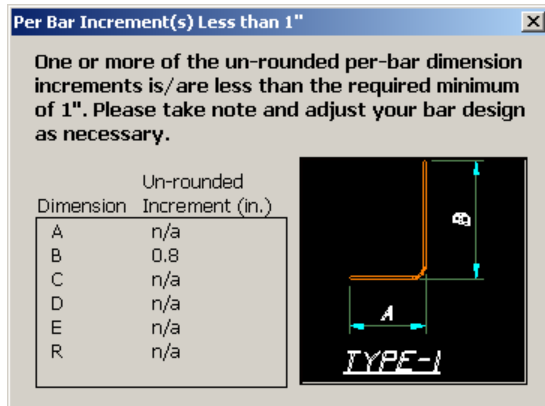
- The user must indicate whether the entries are for straight or bent bar.
- For bent bar, the user must enter the bar Type number

- Length-per-bar entries are required.
- The program computes no adjustments for the bent bar. If the user wishes adjustments, he/she must enter the adjusted lengths in the min/max length-per-bar fields.



Dimension Increments Less Than 1"

As stated in the previous two sections, the series bar calculation routines inform the user if one or more un-rounded dimension increments are less than 1". The notification consists of a screen form for shaped bars and a message box for straight bars.



An example of the notification window for standard ODOT shapes is shown to the left (dimension B 1 foot in height varies over 16 bars). A similar window, without the graphic, is used for custom bent bars, and a message box is used for straight bars with sub-minimum increments.

CAVEATS, BUGS, WORK-AROUNDS

At the time of this writing, there are no known bugs in the program. It is expected that some things should come up once the program is distributed for general use. You are also welcome to send us any feedback you may have on the layout of the form (what text box, label, etc., goes where) or what computed information could be added/dropped.

There are a few things that the user should be aware of, though.

First, the bar forms work in decimal feet, meaning that it expects user inputs to be in this format. However, the text output follows the ODOT bar chart standard conventions of:

- Chart length entries are always in feet-inches format
- Length-per-bar values are always rounded to the nearest whole inch
- Bar dimensions (A, B, C, R, etc.) and the increment per bar for series are always rounded to the nearest quarter-inch.

Second, the program does not provide summary/sub-summary weight computations/text for the chart. However, the ODOT standard *vba*, *add.mvba*, should be updated for those functions in the near future. In the meantime, use your calculator.

Third, and this is most important, the add/deduct adjustments the program computes are based strictly upon the CRSI Manual of Standard Practice rather than the ODOT add/deduct charts. See Appendix A for more information.

Fourth, always pay attention to the results the program gives you for your input, especially for the standard bar shapes. The code for these bars' computational equations is fairly complex, and we are not completely sure that all errors, for all possible combinations of situations, have been rooted out.

Fifth, be mindful of per-bar dimension increments for series bar. The required un-rounded minimum increment is 1" in order to provide adequate clearances. The program does notify the user when the minimum is not reached, but does not prevent the bar's information from being placed in the chart. In order to further ensure, then, that users will review the dimension increments, increment text is rounded only to the nearest quarter-inch rather than ODOT typical practice of the nearest full inch, thereby requiring the user to manually examine and edit the increment text.

Furthermore, when a series bar has more than one variable dimension, the text arranges the increments vertically in the INC column. ODOT typical practice is to arrange these additional increments horizontally by making additional columns. It is up to the user to make such changes.

Please note, also, that for Type 2 series bar, where The A and C maximum and minimum dimensions are the same and the B dimension is constant, the program does meet the ODOT standard practice of providing only the single A (or C) increment for the chart text.

Lastly, since the program is expected to be run in the sheet model of the dgn file, it does not provide for rotated views. So, text to be placed in a rotated view will appear somewhere else in the model, NOT on your cursor.

Contacts

If you have any questions, suggestions, or problems please contact the ODOT Office of CADD and Mapping Services CADD Support team or use the following form on the ODOT web site at:

<http://www.dot.state.oh.us/Divisions/Engineering/CADDMapping/CADD/Pages/suggestions.aspx>

APPENDIX A

Appendix A – Basis of Add/Deduct Computations

Discussion

The software seeks to use equations to determine add/deduct values for the Standard ODOT shapes. Because the ODOT bar bending charts do not provide information on their underlying mathematical basis, the reference for the charts, the CRSI Manual of Standard Practice was consulted. Furthermore, there are apparent errors in the ODOT charts – most notoriously the 135 degree deductions.

The CRSI's geometric drawings and standard bend tables were used to establish constants and develop equations for additions for 90 and 135 degree end ties and hooks on stirrup bars, and 90 and 180 degree end hooks for non-stirrup bars. Because these are the only bending degree values that are encountered in ODOT end hooks or ties, the program DOES NOT compute additions for any other angles. For stirrup bars, the 90 degree addition will be computed if the angle is other than 135 or 90 degrees; for the non-stirrup bars, the 180 degree addition is computed if the angle is other than 180 or 90 degrees.

Furthermore, the program provides addition values for stirrup bar sizes 3 through 8, which is in keeping with the CRSI; the ODOT charts provide addition values only through size 5.

Deducts are used with interior bends and can be for any size angle. There is some evidence of past practice that attempts to interpolate from the ODOT charts. Such interpolation is erroneous for several reasons. First, deductions, as functions of the angle of the bend and the bending diameter, are not linear. Second, the ODOT deduction chart has some angles (45 and 135 degrees) based upon stirrup bar bending diameters, and others (90 and 180 degrees) based upon non-stirrup bar bending diameters.

Two deduction equations were derived from the geometric drawings and bend tables in the CRSI, one for 180 degree angles and another for angles less than 180 degrees. The two equations are functions of bar size, bending diameter, and angle of bend. As bends greater than 180 degrees are not encountered, no deduction equations for such values were developed.

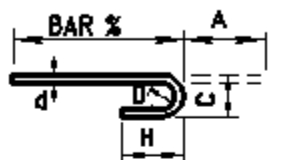
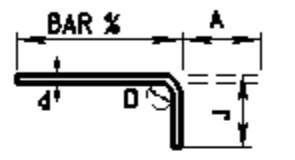
The charts on the next few pages show the equations and rounding rules (and, in the case of additions, constants) used by the program to do its adjustments. They have been checked against the CRSI and the ODOT standard charts. The results with the CRSI are excellent, and the ODOT standard charts also compare quite well with the exception of the 135 degree deductions and a few small round-off differences.

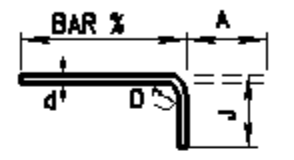
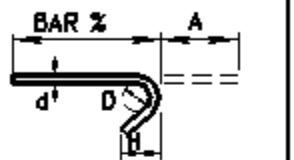
A copy of the relevant sheet from the CRSI is also included for reference.

APPENDIX A

Appendix A – Basis of Add/Deduct Computations

Add Charts

ADD-INS for END HOOKS									
BAR BENDING DATA (DIMENSIONS IN INCHES) for End Hooks									
BAR NO.	 180° Bend				 90° Bend				BAR NO.
	D	A	H	C	D	A	J	J-A	
3	2 1/4	5	4	3	2 1/4	5	6	1	3
4	3	6	4 1/2	4	3	7	8	1	4
5	3 3/4	7	5	5	3 3/4	8 1/2	10	1 1/2	5
6	4 1/2	8	5 3/4	6	4 1/2	10	12	2	6
7	5 1/4	10	7 1/2	7	5 1/4	12	14	2	7
8	6	11	8	8	6	13 1/2	16	2 1/2	8
9	9 1/2	15	10	11 3/4	9 1/2	15 1/2	19	3 1/2	9
10	10 3/4	17	11 1/2	13 1/4	10 3/4	18	22	4	10
11	12	19	12 3/4	14 3/4	12	20	24	4	11
14	18 1/4	27	17 1/4	21 3/4	18 1/4	25	31	6	14
18	24	36	23 1/4	28 1/2	24	33	41	8	18
BENDING TOLERANCES: Refer to Section CMS 509									
$A_{180} = 1/2(D+d)(\pi) + H - 2(d+D/2)$, round to nearest half $A_{90} = 1/2(D+d)(\pi/2) + J - 2(d+D/2)$, round to nearest half									

ADD-INS for Stirrup and Tie Hooks									
BAR BENDING DATA (DIMENSIONS IN INCHES) for Stirrups and Tie Hooks									
BAR NO.	 90° Bend				 135° Bend				BAR NO.
	D	A	J	J-A	D	A	H		
3	1 1/2	3	4	1	1 1/2	4	2 1/2	3	
4	2	3 1/2	4 1/2	1	2	4 1/2	3	4	
5	2 1/2	4 1/2	6	1 1/2	2 1/2	5 1/2	3 3/4	5	
6	4 1/2	10	12	2	4 1/2	8	4 1/2	6	
7	5 1/4	12	14	2	5 1/4	9	5 1/4	7	
8	6	13 1/2	16	2 1/2	6	10 1/2	6	8	
As per the provisions of the CRSI Manual of Standard Practices, this chart is to be used with ODOT Standard Bar Types 3 and 4 and other stirrup bar designs.									
BENDING TOLERANCES: Refer to Section CMS 509									
$A_{135} = 1/2(D+d)(3\pi/4) - (d+D/2) + H - (d+D/2)(1-\cos(45))/(\cos(45))$ where $6d < 3"$ $A_{135} = 1/2(D+d)(3\pi/4) - (d+D/2) + 6d$ where $6d > 3"$ Round to nearest half for #3, #4 and #6 bars Round up to nearest half for #6, #7 and #8 bars $A_{90} = 1/2(D+d)(\pi/2) + J - 2(d+D/2)$, round to nearest half									

Appendix A – Basis of Add/Deduct Computations

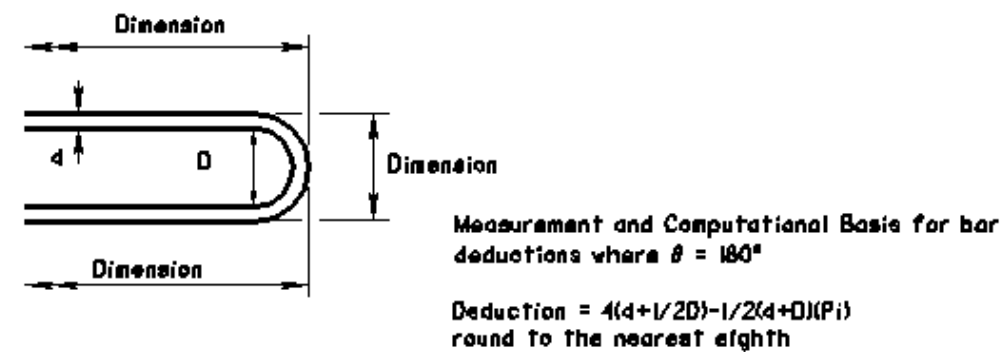
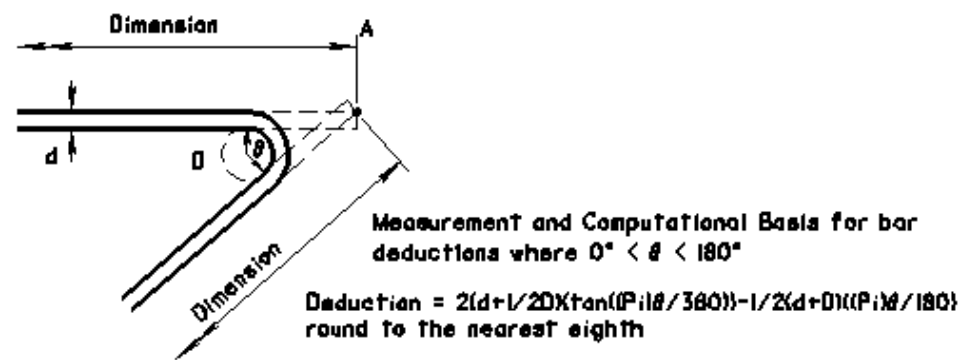
Deduct Charts

STD. BAR LENGTH DEDUCTIONS FOR COMMON BENDS, (IN) for Stirrup Bars								
BAR NO.	STANDARD BEND (DEGREES)							
	0	45°	0	90°	0	135°	0	180°
#3	1/2"	1/4"	1/2"	3/4"	1/2"	1 3/8"	1/2"	1 1/2"
#4	2"	1/4"	2"	1"	2"	2 1/2"	2"	2"
#5	2 1/2"	3/8"	2 1/2"	1 1/4"	2 1/2"	3 3/8"	2 1/2"	2 3/8"
#6	4 1/2"	3/8"	4 1/2"	1 7/8"	4 1/2"	5 5/8"	4 1/2"	3 3/4"
#7	5 1/4"	1/2"	5 1/4"	2 1/4"	5 1/4"	6 1/2"	6 1/4"	4 3/8"
#8	6"	1/2"	6"	2 1/2"	6"	7 1/2"	6"	5"

NOTE:
"D" IS THE DIAMETER OF THE BEND PER CONSTRUCTION
AND MATERIAL SPECIFICATIONS ITEM 509.05

STD. BAR LENGTH DEDUCTIONS FOR COMMON BENDS, (IN)								
BAR NO.	STANDARD BEND (DEGREES)							
	0	45°	0	90°	0	135°	0	180°
#3	2 1/4"	1/4"	2 1/4"	1"	2 1/4"	2 3/4"	2 1/4"	1 1/8"
#4	3"	1/4"	3"	1 1/4"	3"	3 3/4"	3"	2 1/2"
#5	3 3/4"	3/8"	3 3/4"	1 5/8"	3 3/4"	4 5/8"	3 3/4"	3 3/8"
#6	4 1/2"	3/8"	4 1/2"	1 7/8"	4 1/2"	5 5/8"	4 1/2"	3 3/4"
#7	5 1/4"	1/2"	5 1/4"	2 1/4"	5 1/4"	6 1/2"	5 1/4"	4 3/8"
#8	6"	3/8"	6"	2 1/2"	6"	7 1/2"	6"	5"
#9	8 1/2"	3/4"	8 1/2"	3 3/8"	8 1/2"	11 3/4"	8 1/2"	6 3/4"
#10	10 3/4"	3/4"	10 3/4"	3 3/8"	10 3/4"	13 3/8"	10 3/4"	7 5/8"
#11	12"	3/8"	12"	4 1/4"	12"	14 1/8"	12"	8 1/2"
#14	18 1/4"	1 1/8"	18 1/4"	6"	18 1/4"	22 5/8"	18 1/4"	12 1/8"
#18	24"	1 1/2"	24"	7 3/8"	24"	28 3/4"	24"	15 3/4"

NOTE:
"D" IS THE DIAMETER OF THE BEND PER CONSTRUCTION
AND MATERIAL SPECIFICATIONS ITEM 509.05



Appendix A – Basis of Add/Deduct Computations

CRSI Reference

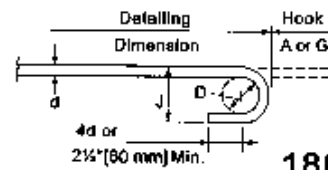
RECOMMENDED INDUSTRY PRACTICE FOR DETAILING REINFORCING MATERIALS

STANDARD HOOKS

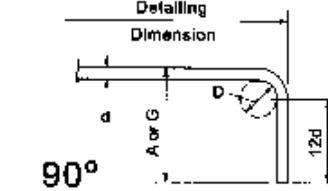
All specific dimensions recommended by CRSI below meet minimum requirements of ACI 318 [318M].

RECOMMENDED END HOOKS
All Grades of Steel
D = Finished band diameter

Bar Size	D, in. [mm]	180° Hooks, ft-in. [mm]		90° Hooks, ft-in. [mm]
		A or G	J	A or G
# 3 [#10]	2½ [80]	0-5 [125]	0-3 [80]	0-8 [150]
# 4 [#13]	3 [80]	0-6 [150]	0-4 [105]	0-8 [200]
# 5 [#18]	3¾ [95]	0-7 [175]	0-5 [130]	0-10 [250]
# 6 [#19]	4½ [115]	0-8 [200]	0-6 [155]	1-0 [300]
# 7 [#22]	5¼ [135]	0-10 [250]	0-7 [180]	1-2 [375]
# 8 [#25]	6 [155]	0-11 [275]	0-8 [206]	1-4 [425]
# 9 [#29]	9¼ [240]	1-3 [375]	0-11¾ [300]	1-7 [475]
# 10 [#32]	10¾ [275]	1-5 [425]	1-1¾ [335]	1-10 [550]
# 11 [#36]	12 [306]	1-7 [476]	1-2¾ [375]	2-0 [800]
# 14 [#43]	18¼ [465]	2-3 [675]	1-8¾ [550]	2-7 [775]
# 18 [#57]	24 [610]	3-0 [826]	2-4½ [725]	3-5 [1050]

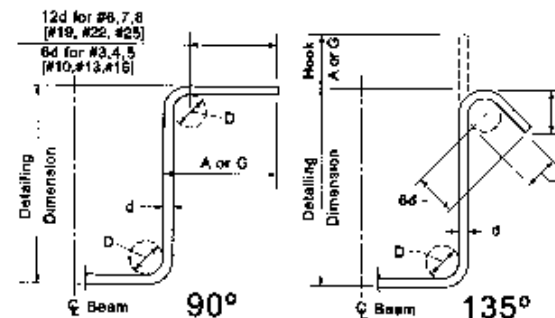


180°



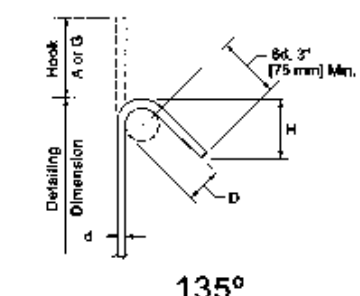
90°

90° AND 135° STIRRUP AND TIE HOOKS



90° 135°

135° SEISMIC STIRRUP/TIE HOOKS



135°

STIRRUP (TIES SIMILAR)
STIRRUP AND TIE HOOK DIMENSIONS
ALL GRADES OF STEEL

Bar Size	D, in. [mm]	90° Hook, ft-in. [mm]		135° Hook, in. [mm]	
		Hook A or G	Hook A or G	H (Approx.)	H (Approx.)
#3 [#10]	1½ [40]	0-4 [106]	4 [105]	2½ [65]	
#4 [#13]	2 [50]	0-4½ [115]	4¾ [115]	3 [80]	
#5 [#18]	2½ [65]	0-5 [166]	5¾ [140]	3¾ [96]	
#6 [#19]	4¾ [115]	1-0 [305]	7 [205]	4¾ [115]	
#7 [#22]	5¼ [135]	1-2 [356]	9 [230]	5¼ [136]	
#8 [#25]	6 [155]	1-4 [410]	10¾ [270]	6 [155]	

135° SEISMIC STIRRUP/TIE HOOK DIMENSIONS
ALL GRADES OF STEEL

Bar Size	D, in. [mm]	135° Hook, in. [mm]	
		Hook A or G	H (Approx.)
#3 [#10]	1½ [40]	4¾ [110]	3 [80]
#4 [#13]	2 [50]	4¾ [115]	3 [80]
#5 [#18]	2½ [65]	5¾ [140]	3¾ [95]
#6 [#19]	4¾ [115]	8 [205]	4¾ [115]
#7 [#22]	5¼ [135]	9 [230]	5¼ [135]
#8 [#25]	6 [155]	10¾ [270]	6 [155]

6-6