

Barlines Rebar Detailing Standards in the Philippines

METRIC (SI), STANDARD HOOKS AND OTHER DETAILING CRITERIAS

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INTRODUCTION

This is first in a series of articles outlining the Code of Standards Barlines Reinforcing Steel Company Detailers adhere to in the practice of Reinforcing Steel Engineering in the Philippines. Because the current practice in the Philippines is still predominantly “cut-and-bend” at the jobsite – the practice of rebar estimating, detailing, fabrication and even installation varies from job to job. And the general absence of sophisticated fabricating equipment and industry organizations sometimes called upon in general notes and specifications to provide quality control is are at times conflicting. We have noted that on many occasions, mandatory language are used specifying compliance to the Concrete Reinforcing Steel Institute (CRSI), when CRSI has no presence at all in the Philippines and their standards are not at all completely applicable. While CRSI standards is a good template to draw from – Barlines found itself tweaking the standards some to make it work in the Philippines, which we are sure everyone does.

Because the author was a member of the CRSI Committee on Reinforcing Bar Detailing and that Barlines mother company has done work in many countries of the world and have learned to adapt to so many rebar engineering standards, the task seem easier assigned to Barlines. It is hoped that by writing these series of articles – A Code of Standard Practice can be adopted in the Philippines.

METRIC vs. IMPERIAL

In the International System of Measurement (SI), the Metric System, all dimensions in Reinforcing Steel Placing Drawings shall be shown in millimeters, thus: 365, 625, 720, 9 000. Some may show a space between thousands and hundreds, but such is not mandatory. By adopting this standard the use of “mm” abbreviations becomes unnecessary. Spacing of bars, dimensions and lengths of bars shall also be shown in millimeters. To follow the practice in the United States and to conform to calibration of fabricating equipments, rebar dimensions shall be rounded to the nearest inch or 25mm for end-hooks and to the nearest quarter inch or 5mm for stirrup and tie hooks. These increments also are compatible to tolerances in fabrication and bar placement.

The Philippine National Standard (PNS) bar sizes are not universal. It is worth comparing the bar sizes to have a grasp of its effect on standard hooks.

Table A100.1

BAR SIZE COMPARISON

Philippines		Canada, Intl		United States	
Bar Size	Area, Sq. mm.	Bar Size	Area, Sq. mm.	Bar Size	Area, Sq. mm.
				#3/10m	71
10m	78.5				
		10m	100		
12m	113.1				
		15m	200	#4/13m	129
				#5/16m	199
16m	201.1				
				#6/19m	284
		20m	300		
20m	314.2				
				#7/22m	387
25m	490.9				
		25m	500		
				#8/25m	510
28m	615.8				
				#9/29m	645
		30m	700		
32m	804.3				
				#10/32m	819
		35m	1000		
				#11/36m	1006
36m	1017.9				
40m	1256.6				
				#14/43m	1452
		45m	1500		
50m	1963.5				
		55m	2500		
				#18/57m	2581

You will note in the above bar size comparison table, 10m, 16m and 36m of the Philippines are a bit larger than bar sizes of the United States. It follows, that except for these bar sizes, all standard hooks required by the American Concrete Institute (ACI) for the U.S. bar sizes can be maintained in the Philippines with very minor adjustments.

AVAILABLE STOCK LENGTHS

Unique in the Philippines, bars are available in multiple stock lengths. Because of the absence of fabricating equipments, the Mills took upon themselves to make available various lengths to reduce the amount shearing that will be needed in a “cut-and-bend” practice at the jobsite. Bars in the Philippines are available in: 6.00, 7.50, 9.00, 10.50, and 12.00 meters. On a special order, 15.00 meters can be made available.

STANDARD HOOKS

To avoid hairline cracks induce by excessive bending stresses, the ACI established controls by specifying the minimum inside radius or inside diameter of bend that can be made for each size of bar. This minimum bend diameter is commonly know in fabrication is as the “pin” diameter. The radius of diameter of the bend is usually expressed as a multiple of the nominal diameter of the bar d_b . The ratio of diameter of bend to diameter of bar is not a constant because it has been found by test that this ratio must be larger as the bar size increases. The minimum pin diameters of bend specified by ACI 318 (318M) for reinforcing bars are as follows:

Bar Sizes (mm)	Other than Ties/Stirrups	Ties Or Stirrups
8m	$6 d_b$	$4 d_b$
10m, 12m, 16m	$6 d_b$	$4 d_b$
20m, 25m	$6 d_b$	$6 d_b$
28m, 32m, 36m	$8 d_b$	
40m, 50m	$10 d_b$	

d_b = nominal bar diameter

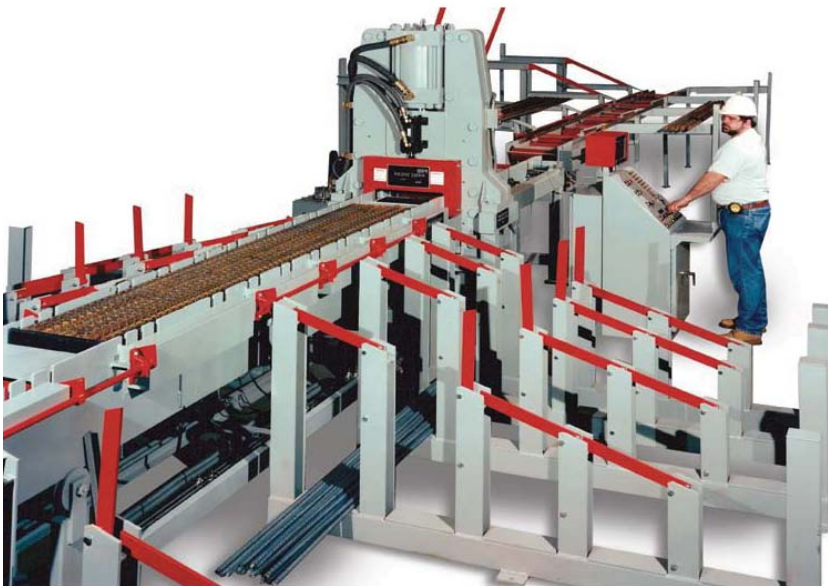
Besides the requirements of ACI 318, the rounding of end-hooks to the nearest 25 mm and stirrup and ties to the nearest 5 mm – allowance for spring back in fabrication and maintaining a policy of production fabrication pin size no smaller than the ASTM A615/A615M bend test pin size were all recognized as well. In the Tables, the extra length of bar allowed for hook is designated as A or G. The A and G for hooks made it possible for software developers to program them as such. For example, a Barlines Detailer, using a detailing software only need to enter the plus (+) or minus (-) key to recall a standard hook dimensions for any size bar at the A

or G cells. Using Microsoft EXCEL spreadsheet, one can embed a lookup table at those same cells, eliminating memorizing all the different hook dimensions. As an added rule, the A or G can also be a dimension less but not more than standards (See Table of the minimum A or G Dimension).

Fabricating equipment most likely will be coming from the United States, China or Korea. Barlines equipment is all from KRB Machinery of Pennsylvania, U.S.A., and the same equipment that fabricated the PETRONAS Towers in Malaysia.

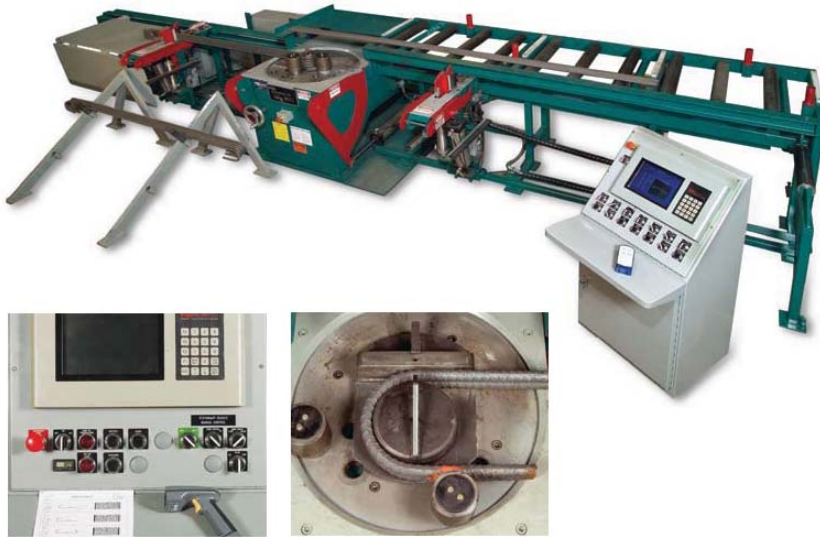
PHOTOS

Here are some photos of Barlines Fabricating Equipment from KRB.



The KRB Shear line, with the loading table at the right side of the shear head, the measuring conveyor and the sorting table on the left side of the shear head. In this instance, the multiple bars have been blocked (blocker calibrated every 5 mm) and sheared off. At the push of a button by the operator, the bars will be lifted and slid into the open bin no.2, while bin no. 1 is closed with bars of different length or size than on the conveyor.

Below is the KRB Heavy bender. Notice the pin size around which the bar was bent. Notice also the extra length at the end required by the pin to catch. Shorter than standard may make it impossible to bend the bar.



2D Bar Coding Optional

Below is a photo of Barlines “Green Elephant” – KRB Stirrupmatic. It is capable of shearing and bending multiple stirrup/ties both in straight rods and in coiled rebar, in bar sizes 10m, 13m and 16m, in one operation. While coil is still not readily available in the Philippines, Barlines is able to get them from Taiwan. With Coils rebar waste is reduce from one remnant every 12 meter stock to 1 remnant every 3000 meter stock. Again this machine is calibrated in increments of 5 mm.



Table A100.02

THE PHILIPPINES METRIC REINFORCING BARS

BAR SIZE Designation	NOMINAL DIMENSIONS		
	AREA Square Millimeter	MASS Kilogram per Meter	DIAMETER Millimeter
#8	50.3	0.394	8
#10	78.5	0.616	10
#12	113.1	0.888	12
#16	201.1	1.578	16
#20	314.2	2.466	20
#25	490.9	3.853	25
#28	615.8	4.834	28
#32	804.3	6.313	32
#36	1017.9	7.990	36
#40	1256.6	9.865	40
#50	1963.5	15.413	50

The reinforcing steel shown above are available according to PNS Grade 230 (ASTM Grade 33) from size #8 to #36; PNS Grade 275 (ASTN Grade 40) from size #10 to #36; and PNS Grade 415 (ASTM Grade 60) from size #10 to #50. PNS Grade 415 also is available marked with “W” which denotes weldable property.

Barlines Rebar Detailers and Estimator shall be mindful of the PNS Grades and Weldability requirements of reinforcing steel. Barlines assumes that weldable grades conforms to ASTM A706, Grade 60 bars, which is Low Alloy Steel, required for bars that are welded and on Ductile Frame or Boundary Elements of Shear Walls in Seismic Zone 4, such as the entire Philippines.

It is not, however, the responsibility of a Rebar Detailer to change the grades of rebar as specified by the Design-Engineer.

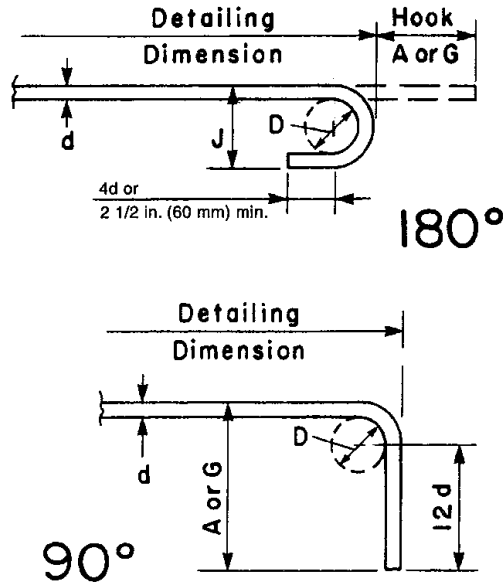
Barlines Rebar Detailers shall detail standard hooks on bars according to these minimum:

- ACI 318 (318M) minimum bend diameters,
- Rounding to 5 mm and 25 mm increments,
- Spring back in fabrication, and
- Fabricating Equipment calibration.

Table A100.03

RECOMMENDED END HOOKS, All Grades

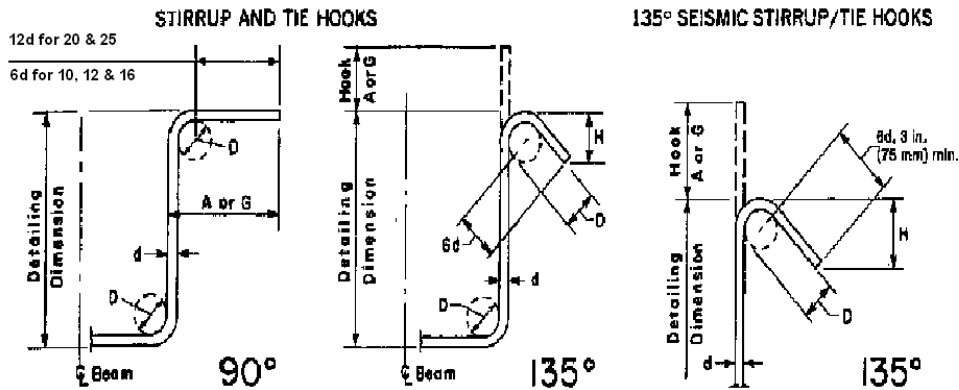
D = Finished bend Diameter (Pin Diameter)



Bar Size	D* (mm)	180 degree hook		90 degree hook
		A or G (mm)	J (mm)	A or G (mm)
#8	50	100	65	125
#10	60	150	80	150
#12	80	175	105	200
#16	100	200	130	250
#20	135	250	180	375
#25	155	275	205	425
#28	240	375	300	475
#32	275	425	335	550
#36	305	475	375	625
#40	400	675	500	725
#50	500	850	600	900

*Finished bend diameters include “spring back” effect when bars straighten out slightly after being bent and are slightly larger than minimum bend diameters in ACI Chapter 3, Section 7.2.

Table A100.04



STIRRUP AND TIE HOOK DIMENSIONS (All Grades)

Bar Size	D* (mm)	90 degree hook	135 degree hook	
		Hook A Or G (mm)	Hook A or G (mm)	H Approx (mm)
10	40	105	105	65
12	50	115	115	80
16	65	155	140	95
20	120	355	230	135
25	155	410	270	155

135 DEGREE SEISMIC STIRRUP/TIE HOOK DIMENSIONS (All Grades)

Bar Size	D* (mm)	135 degree hook	
		Hook A or G (mm)	H Approx (mm)
10	40	110	80
12	50	115	80
16	65	140	95
20	120	230	135
25	155	270	155

*Same note as in table A100.03

OTHER DETAILING CRITERIAS**RADIAL PREFABRICATION (Bend Type 9)**

When reinforcing bars are used around a curved surfaces, such as domes or tanks and when no special requirement is established in the contract, such bars shall be detailed and prefabricated in accordance with the criteria established in the following table.

TABLE A100.05

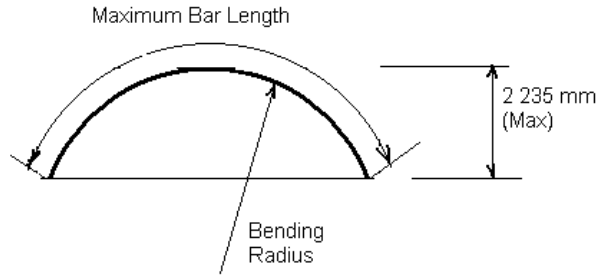
Bar Size	Bars are to be fabricated when either the radius or bar length is less the tabulated value	
	Radius (meter)	Bar Length (meter)
#10	1.50	3.00
#12	3.00	3.00
#16	4.50	3.00
#20	12.00	3.00
#25	18.00	9.00
#28	27.00	9.00
#32	33.00	9.00
#36	33.00	18.00
#40	54.00	18.00
#50	90.00	18.00

Bars will be furnished straight for all other conditions. The straight bars will then have to be sprung in place to fit. Radially prefabricated bars of any size tend to relax the radius originally prefabricated as a result of time and normal handling. The last few millimeters involved in the lap splice area often appears as a tangent rather than an arc due to limitations of standard bending equipment.

The presence of the tangent end may not cause any problem on most bars since they are generally lap spliced. However, for sizes #40 and #50 bars cannot be lap spliced and are usually spliced using a mechanical splice or spliced by butt welding. It is a problem to place a radially bent bar when using mechanical splice due to the tangent ends on bars bent to a small radii. To avoid this problem, all #40 and #50 bars bent to a radius of 6100 mm or less shall be detailed and furnished with an additional 450 mm added to each end. Bars bent to radii greater than 6100 mm will be detailed and furnished to the detailed length with no considerations given to the tangent end.

LOADING LIMITS

Table A100.06

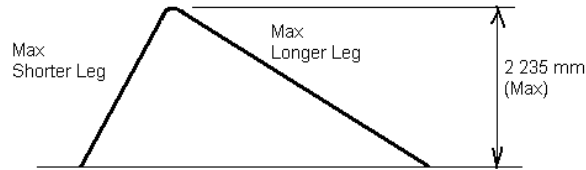


MAXIMUM ARC LENGTH FOR SHIPPING

Radius	Max length	Radius	Max Length	Radius	Max Length	Radius	Max Length
1 219	6 172	4 115	9 016	7 010	11 506	9 906	13 563
1 372	6 224	4 267	9 168	7 162	11 634	10 058	13 664
1 524	6 272	4 419	9 320	7 315	11 759	10 210	13 767
1 676	6 400	4 572	9 448	7 467	11 862	10 363	13 868
1 829	6 553	4 724	9 601	7 620	11 987	10 515	13 968
1 981	6 730	4 877	9 729	7 772	12 091	10 667	14 072
2 133	6 909	5 029	9 881	7 924	12 191	10 820	14 173
2 286	7 086	5 181	10 006	8 077	12 319	10 972	14 249
2 438	7 263	5 334	10 134	8 229	12 420	11 125	14 349
2 591	7 415	5 486	10 286	8 382	12 521	11 277	14 453
2 743	7 595	5 639	10 415	8 534	12 649	11 429	14 529
2 895	7 772	5 791	10 539	8 686	12 749	11 582	14 630
3 048	7 924	5 943	10 667	8 839	12 853	11 734	14 730
3 200	8 101	6 096	10 795	8 991	12 953	11 887	14 806
3 353	8 254	6 248	10 920	9 144	13 054	12 039	14 910
3 505	8 406	6 400	11 048	9 296	13 158	12 191	15 000
3 657	8 558	6 553	11 149	9 448	13 258	12 344	15 000
3 810	8 711	6 705	11 277	9 601	13 359	12 496	15 000
3 962	8 863	6 858	11 405	9 753	13 462	12 649	15 000

Total Length over 12 000 mm.

Table A100.07



MAXIMUM RIGHT ANGLE LEG FOR SHIPPING

SHORTER LEG	MAX LONGER LEG	SHORTER LEG	MAX LONGER LEG	SHORTER LEG	MAX LONGER LEG
2 285	10 645	2 590	4 420	2 895	3 505
2 310	8 765	2 615	4 290	2 920	3 455
2 340	7 645	2 645	4 190	2 950	3 430
2 360	6 910	2 665	4 090	2 970	3 375
2 390	6 350	2 690	3 990	3 000	3 355
2 415	5 920	2 720	3 910	3 025	3 300
2 440	5 590	2 745	3 835	3 050	3 280
2 460	5 310	2 770	3 790	3 070	3 250
2 490	5 055	2 795	3 710	3 100	3 225
2 515	4 875	2 820	3 660	3 125	3 175
2 540	4 700	2 845	3 605	3 150	3 150
2 565	4 545	2 870	3 555		

Total Length over 12 000 mm.

Tables A100.06 shows, for various radii of bending, the maximum length of reinforcing bar that will not exceed 2 235 mm. Table A100.07 shows, for L-shaped bars, the right angle dimension from the apex to a straight line between the ends of the bar not exceeding 2 235 mm.

The above is for single bar. Bundles of bars occupy a greater space, therefore 2 235 mm limit has been selected rather the 2 400 mm maximum load limit. Generally, shipping widths greater than 2 400 mm require the permission of authorities or must be shipped under special freight rates.