Chapter 4
Bridge Program Drawings

Section 4.19-Reinforcing Steel

Introduction

Because concrete has a low tensile strength, reinforcing steel is embedded in the concrete to resist the applied loads causing tension. Compressive reinforcing steel can be used in beams and columns to reduce the size of these members. In addition, reinforcing steel can control strain and subsequent concrete cracking from temperature and shrinkage and distribute applied loads to other reinforcing steel.

Reinforcing steel is in the form of bars or wires whose surface may be coated, smooth, or deformed. Deformed bars are generally used because they produce better bond with the concrete due to the raised patterns on the steel. Smooth bars are generally used in welded wire fabric.

Reinforcing Steel Types

DEFORMED BARS range in diameter from ⅜" to 2¼". Bar sizes are designated by a number, which is approximately eight times the bar diameter. The most commonly used bars are No. 4 through No. 11 bars, with No. 3 bars being limited to use as spiral reinforcing in columns. Reinforcing steel shall have yield strength of 60,000 psi (Grade 60).

WELDED WIRE FABRIC consists of a rectangular grid of uniformly spaced smooth wires, welded at their intersections. Welded wire fabric offers fast and easy field placement.

General Design and Detail Information

REINFORCING STEEL COVER refers to the clear distance from the concrete surface to the face of the reinforcing steel. Minimum clearances must be maintained to protect the reinforcing steel from corrosion and to allow for proper concrete placement. Concrete cover to the face of reinforcing steel shall be 2" unless noted. It is not necessary to provide any cover from an internal construction joint. The end of the bar may be placed against or rest on the joint. Other exceptions include the following.

Curb, sidewalk, and barrier rail contraction joint	1"
Drilled hole to face of reinforcing	1"
Bridge decks - top of deck	2½"
- bottom of deck	1"
Curbs and sidewalks - top and sides Bridge barrier rail- sides	1½"
Any concrete surface resting on or placed against earth	
- bottom of spread footing	3"
- bottom of bottom slab of culvert	3"
- bottom of abutment wingwall	3"
- bottom of drilled shafts	0"
T-girder and box girder webs - bottom face and sides Bottom slab of box girder- top and bottom faces Column - diameter < 48" Bottom of approach slabs Bottom of slope paving	1½"
Drilled shaft foundation, side clearance	3" (Min)

Concrete cover on precast concrete sections shall conform to AASHTO requirements.

Reinforcing steel is identified on the Bridge Program drawings by **BAR MARKS**. Bar marks identify each bar by designating the bar size and length in the case of a straight bar and the bar size, structural unit, and unique number for a specific unit of the structure for bent bars. The unique number for each specific unit shall be numbered consecutively.

Straight bars are marked as follows.

Mark	**ASTM Bar Size**	**Length**
405-10	No. 4	5'-10"
817-3	No. 8	17'-3"
1025-6	No. 10	25'-6"

Bent bars (ties, stirrups, cranks, etc,) are marked as follows.

Mark	**ASTM Bar Size**	**Designation**
4B4 (Tie)	No. 4	B4
7A3 (Stirrup)	No. 7	A3
5S1	No. 5	SI
Spiral 3B3	No. 3	B3

The following letters shall be used as standard designators for each structural unit.

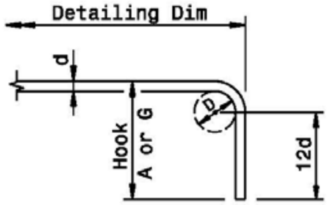
A: Abutment
AS: Approach Slab
B: Bent/Pier
C: Reinforced Concrete Box Culvert
G: Concrete Girder
R: Concrete Bridge Barrier Rail
S: Slab
W: Retaining Wall

When the word **TIE** or **STIRRUP** follows a bent bar designation, it refers to the type of bent bar. Closed bent bars should be designated as ties, while open bent bars should be designated as stirrups. The word tie or stirrup informs the fabricator that minimum bends are required. Lengths of bent bars are shown in the Bill of Reinforcement.

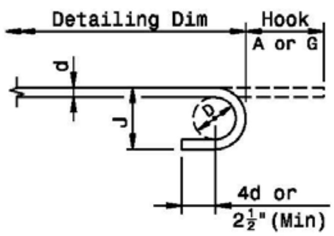
The following table shows the American Concrete Institute standards for hooks. Any hook shown on the plans and not otherwise dimensioned shall conform with the hooks shown in this table.

STANDARD HOOKS - GRADE 60

END HOOK



90° HOOK

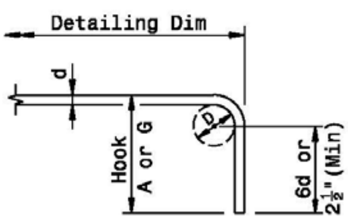


180° HOOK

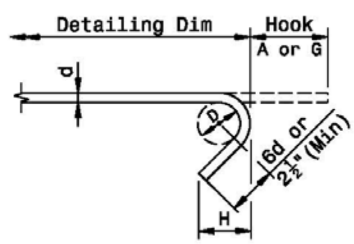
Bar Size	d	D	90° HOOK	180° HOOK	
			Hook A or G	Hook A or G	J
# 3	⅛"	2¼"	6"	5"	3"
# 4	½"	3"	8"	6"	4"
# 5	⅝"	3¾"	10"	7"	5"
# 6	¾"	4½"	1'-0"	8"	6"
# 7	⅞"	5¼"	1'-2"	10"	7"
# 8	1"	6"	1'-4"	11"	8"
# 9	1⅛"	9"	1'-7"	1'-3"	11¼"
# 10	1¼"	10¼"	1'-10"	1'-5"	1'-0¾"
# 11	1⅜"	11¼"	2'-0"	1'-7"	1'-2¼"
# 14	1¾"	1'-5"	2'-7"	2'-2"	1'-8½"
# 18	2¼"	1'-10¾"	3'-5"	2'-11"	2'-3"

STIRRUP & TIE HOOK

Bar Size	d	D	90° HOOK	135° HOOK	
			Hook A or G	Hook A or G	H
# 3	⅜"	1½"	4"	4"	2½"
# 4	½"	2"	4½"	4½"	3"
# 5	⅝"	2½"	6"	5½"	3¾"
# 6	¾"	4½"	1'-0"	8"	4½"
# 7	⅞"	5¼"	1'-2"	9"	5¼"
# 8	1"	6"	1'-4"	10½"	6"



90° STIRRUP HOOK
(Ties similar)



135° STIRRUP HOOK
(Ties similar)

Reinforcing steel shall be **BILLED** in either the plan or elevation and called out in the section. When circumstances dictate, it may be necessary to bill the bar in the section. Billing is the method by which the required number, or count, of any bar is determined. Each bar shall be billed only once, but may be called out more than once elsewhere on the plans. The billing of bars is determined from the spacing for a particular group of bars.

Billing	**Number Required**
747-2 @ 3 Spa	4 Bars
405-10 @ 12"=22'-0"	23 Bars
7A3 @ 6"=15'-6" (T&B)	64 Bars (32 top face and 32 bottom face)
817-3 @ 12"=9'-0" (EF)	20 Bars (10 each face)
609-8 @ 10 Eq Spa=9'-6"	11 Bars
4B4 @ 24"=12'-0"(4 per line)	28 Bars
5B3 @ 6"=4'-6" (Pairs)	20 Bars

The maximum bar length is 60'-0".

BAR SPACING shall be shown in inches, with the distance between the two end bars for any mark totaled and shown in feet and inches. When the first bar of any mark is referenced from a concrete edge and the distance is greater than l'-0", that distance may be shown in feet and inches.

SPIRALS are lateral reinforcement used in columns and drilled shafts and are generally a No. 3 or No. 4 bar bent at a specific spacing or pitch. Vertical bars, or channel spacers, are furnished with each spiral to hold the spiral in place during placing of concrete. The core dimension for a spiral is the outside diameter of the reinforcement. Spirals require additional information for fabrication. The following data is generally shown in the Bill of Reinforcement.

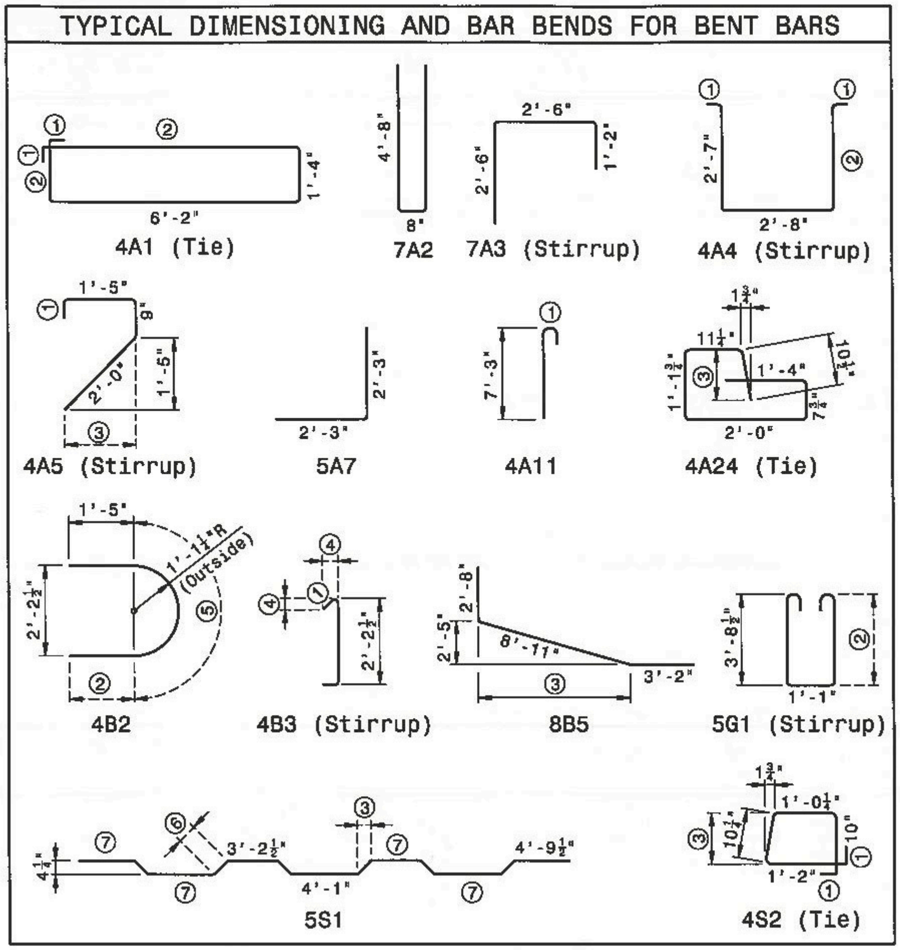
Spiral 3B2: Pitch 3", Core 33", Turns 103

For columns, the number of turns is equal to the length of the column plus the distance from the top of the column to the bottom steel in the cap, divided by the pitch, plus one and one-half turns (top and bottom) required for development. For drilled shaft foundations, the number of turns is equal to the length of the drilled shaft foundation divided by the pitch, plus one and one-half turns (top only) for development. The number of turns shall be rounded up to the nearest one-half turn. A note shall be included on the sheet with the Bill of Reinforcement stating the number of turns required top and/or bottom. The table shown in Chapter 5 - Quantities can be used to calculate the weight of spiral reinforcement per vertical foot of column or drilled shaft.

Often, with sloping surfaces and uniformly spaced bars, each bar length will be different. Rather than calling out each individual bar, a **SET** may be employed. Each group of bars will require a unique number identifying the set, with the first and last bars being called out. A set will be billed in the following manner.

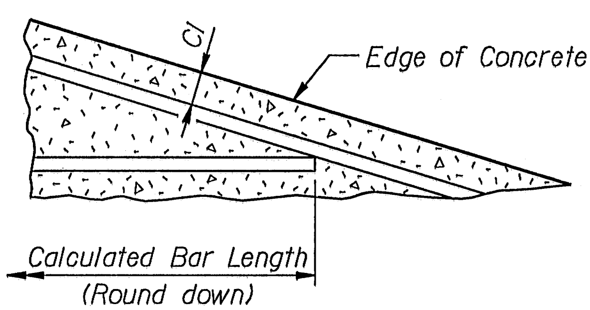
Set 1 Bars @ 6" =12'-6"

Bent bars are detailed to the nearest ¼" out to out with the total length rounded up to the whole inch. Straight bars are detailed to the nearest whole inch. The average length of set bars shall be to the nearest ½". Because reinforcing steel is stocked in standard lengths, bars shall not be detailed greater than 60'-0". In bar runs longer than 60'-0", utilize 60'-0" long bars where possible. When a required bar length is longer than 60'-0", a lap is required. Bars shall be detailed using the maximum bar lengths, and one bar of lesser length placed within the run. The following table shows the dimensions and information required for commonly used bent bars.



① Omit A or G dimensions for hooks (See Standard Hooks table).
② Omit dimension on opposite side of symmetrical bars.
③ Omit run (longest) dimension of bevel only if bevel is 1:1.
④ Omit bevel dimensions on 135° stirrup hooks.
⑤ Omit curved length of bars where radius is shown.
⑥ Omit length of bend on crank bars.
⑦ Omit all repetitive dimensions on symmetrical crank bars.

When calculating bar lengths, consideration should be given to other bars lying in the same plane as the bar whose length is being calculated.



When bar lengths in a group or run require various lengths, rather than using a set, a uniform bar length may be employed to allow the lap between bars to be greater than the required minimum in order to facilitate fabrication and construction.

Reinforcing steel must be **DEVELOPED** for a sufficient length before it can achieve its design strength. This can be accomplished by either **LAPPING** it with other reinforcing steel, or **EXTENDING** it in each direction beyond the critical section. Lap and extension lengths vary depending on the bar size, cover, spacing, location, and concrete strength.

Under AASHTO Standard Specifications, the following shall apply:

A Class C lap is used for most cases. Laps other than Class C shall be designated in the design.

Top bar laps are used for horizontal reinforcing steel when a minimum of 12" of new concrete is placed below the bars.

Class A laps are used in regions of low tensile stress (where tensile reinforcement provided is more than twice that required for strength), if no more than three-quarters of the bars are lapped within a required lap length.

Class B laps are used in regions of low tensile stress (where tensile reinforcement provided is more than twice that required for strength) in regions where more than three-quarters of the bars are lapped within a required lap length; or in regions of high tensile stress (where tensile reinforcement provided is equal to or less than twice that required for strength), if no more than one-half of the bars are lapped within a required lap length.

Class C laps are used in regions of high tensile stress (where tensile reinforcement provided is equal to or less than twice that required for strength), if more than one-half of the bars are lapped within a required lap length.

Tabular values shall not be used in cases of bundled bars, welded splices, positive connections, or for reinforcement in lightweight concrete.

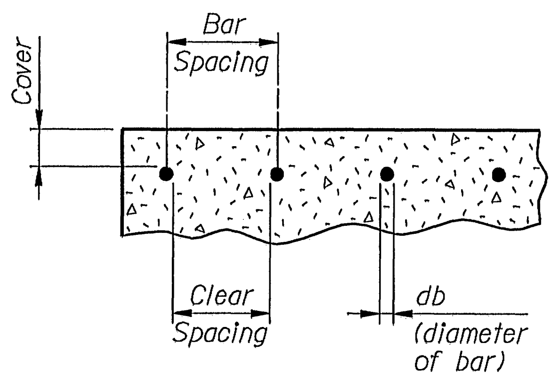
Lap lengths for bars enclosed and lapped inside of a spiral ("lap enclosed in spiral" in the following table) are based on Class C tension lap requirements.

Under AASHTO LRFD Bridge Design Specifications, the following shall apply:

The reinforcing steel table is based on Class B lap. Class B laps shall be used at all locations unless specified in the design.

Top bar laps are used for horizontal reinforcing steel when a minimum of 12" of new concrete is placed below the bars.

The following detail may be used as a guide to determine the correct lap length found in the reinforcing steel tables.



An epoxy coating is used to protect the reinforcing steel from corrosive actions. Epoxy coating shall be used on all bars billed with the bridge deck and curbs, sidewalks, raised medians, barrier rails, and approach slabs.

The following tables list the reinforcing steel properties, laps, and development length to be used for both epoxy coated and uncoated reinforcing steel.

The tables used shall match the design specification used. In general, the AASHTO Standard Specifications will be used for all bridge widening projects and bridge rehabilitation projects. The AASHTO LRFD tables will be used for all new structures.

AASHTO Standard Specifications for Highway Bridges
17th Edition - 2002

UNCOATED BAR PROPERTIES, LAPS, AND DEVELOPMENT LENGTHS
GRADE 60

Bar Size					#4	#5	#6	#7	#8	#9	#10	#11
Weight					0.668 plf	1.043 plf	1.502 plf	2.044 plf	2.670 plf	3.400 plf	4.303 plf	5.313 plf
Diameter					0.5 in	0.625 in	0.75 in	0.875 in	1.00 in	1.128 in	1.27 in	1.41 in
Area					0.20 in²	0.31 in²	0.44 in²	0.60 in²	0.79 in²	1.00 in²	1.27 in²	1.56 in²
f'c = 4000 psi	Bar Spacing ≥ 6"	General	Extension	Comp	0'-10"	1'-1"	1'-3"	1'-6"	1'-8"	1'-11"	2'-1"	2'-4"
				Tens	1'-0"	1'-3"	1'-6"	1'-9"	2'-1"	2'-8"	3'-4"	4'-1"
			Tens Lap - Class C *		1'-5"	1'-9"	2'-1"	2'-8"	3'-7"	4'-6"	5'-8"	7'-0"
			Comp Lap *		1'-3"	1'-7"	1'-11"	2'-3"	2'-6"	2'-10"	3'-3"	3'-7"
			Lap Enclosed in Spiral		1'-1"	1'-4"	1'-7"	2'-0"	2'-8"	3'-4"	4'-3"	5'-3"
		Top Bar	Extension		1'-2"	1'-5"	1'-9"	2'-3"	2'-11"	3'-8"	4'-8"	5'-9"
			Tens Lap - Class C		1'-11"	2'-5"	2'-11"	3'-9"	4'-11"	6'-3"	7'-11"	9'-9"
	Bar Spacing < 6"	General	Extension	Comp	0'-10"	1'-1"	1'-3"	1'-6"	1'-8"	1'-11"	2'-1"	2'-4"
				Tens	1'-0"	1'-3"	1'-6"	2'-0"	2'-7"	3'-4"	4'-2"	5'-2"
			Tens Lap - Class C *		1'-9"	2'-2"	2'-7"	3'-4"	4'-5"	5'-7"	7'-1"	8'-8"
			Comp Lap *		1'-3"	1'-7"	1'-11"	2'-3"	2'-6"	2'-10"	3'-3"	3'-7"
			Lap Enclosed in Spiral		1'-4"	1'-8"	1'-11"	2'-6"	3'-4"	4'-2"	5'-4"	6'-6"
		Top Bar	Extension		1'-5"	1'-9"	2'-2"	2'-9"	3'-8"	4'-7"	5'-10"	7'-2"
			Tens Lap - Class C		2'-5"	3'-0"	3'-7"	4'-8"	6'-2"	7'-10"	9'-11"	12'-2"

* Not for bars enclosed in a spiral
Class A Lap = 59% of Class C Lap
Class B Lap = 77% of Class C Lap

AASHTO Standard Specifications for Highway Bridges
17th Edition - 2002

EPOXY COATED BAR PROPERTIES, LAPS, AND DEVELOPMENT LENGTHS
GRADE 60

Bar Size						#4	#5	#6	#7	#8	#9	#10	#11
Weight						0.668 plf	1.043 plf	1.502 plf	2.044 plf	2.670 plf	3.400 plf	4.303 plf	5.313 plf
Diameter						0.5 in	0.625 in	0.75 in	0.875 in	1.00 in	1.128 in	1.27 in	1.41 in
Area						0.20 in²	0.31 in²	0.44 in²	0.60 in²	0.79 in²	1.00 in²	1.27 in²	1.56 in²
f'c = 4000 psi	Cover ≥ 3db and Clear Spacing ≥ 6db	Bar Spacing ≥ 6"	General	Extension	Comp	0'-10"	1'-1"	1'-3"	1'-6"	1'-8"	1'-11"	2'-1"	2'-4"
					Tens	1'-0"	1'-2"	1'-5"	1'-10"	2'-5"	3'-1"	3'-10"	4'-9"
				Tens Lap - Class C *		1'-7"	2'-0"	2'-5"	3'-1"	4'-1"	5'-2"	6'-6"	8'-0"
				Comp Lap *		1'-3"	1'-7"	1'-11"	2'-3"	2'-6"	2'-10"	3'-3"	3'-7"
				Lap Enclosed in Spiral		1'-3"	1'-6"	1'-10"	2'-4"	3'-1"	3'-10"	4'-11"	6'-0"
			Top Bar	Extension		1'-4"	1'-8"	2'-0"	2'-7"	3'-4"	4'-3"	5'-5"	6'-7"
				Tens Lap - Class C		2'-3"	2'-9"	3'-4"	4'-4"	5'-8"	7'-2"	9'-1"	11'-2"
		Bar Spacing < 6"	General	Extension	Comp	0'-10"	1'-1"	1'-3"	1'-6"	1'-8"	1'-11"	2'-1"	2'-4"
					Tens	1'-2"	1'-6"	1'-9"	2'-4"	3'-0"	3'-10"	4'-10"	5'-11"
				Tens Lap - Class C *		2'-0"	2'-6"	3'-0"	3'-10"	5'-1"	6'-5"	8'-2"	10'-0"
				Comp Lap *		1'-3"	1'-7"	1'-11"	2'-3"	2'-6"	2'-10"	3'-3"	3'-7"
				Lap Enclosed in Spiral		1'-6"	1'-10"	2'-3"	2'-11"	3'-10"	4'-10"	6'-1"	7'-6"
			Top Bar	Extension		1'-8"	2'-1"	2'-5"	3'-2"	4'-2"	5'-4"	6'-9"	8'-3"
				Tens Lap - Class C		2'-9"	3'-6"	4'-2"	5'-5"	7'-1"	9'-0"	11'-5"	14'-0"

* Not for bars enclosed in a spiral
Class A Lap = 59% of Class C Lap
Class B Lap = 77% of Class C Lap

EPOXY COATED BAR PROPERTIES, LAPS, AND DEVELOPMENT LENGTHS
GRADE 60

Bar Size						#4	#5	#6	#7	#8	#9	#10	#11
Weight						0.668 plf	1.043 plf	1.502 plf	2.044 plf	2.670 plf	3.400 plf	4.303 plf	5.313 plf
Diameter						0.5 in	0.625 in	0.75 in	0.875 in	1.00 in	1.128 in	1.27 in	1.41 in
Area						0.20 in²	0.31 in²	0.44 in²	0.60 in²	0.79 in²	1.00 in²	1.27 in²	1.56 in²
f'c = 4000 psi	Cover < 3db or Clear Spacing < 6db	Bar Spacing ≥ 6"	General	Extension	Comp	0'-10"	1'-1"	1'-3"	1'-6"	1'-8"	1'-11"	2'-1"	2'-4"
					Tens	1'-3"	1'-6"	1'-10"	2'-5"	3'-2"	4'-0"	5'-0"	6'-2"
				Tens Lap - Class C *		2'-1"	2'-7"	3'-1"	4'-0"	5'-4"	6'-8"	8'-6"	10'-5"
				Comp Lap *		1'-3"	1'-7"	1'-11"	2'-3"	2'-6"	2'-10"	3'-3"	3'-7"
				Lap Enclosed in Spiral		1'-7"	1'-11"	2'-4"	3'-0"	4'-0"	5'-0"	6'-5"	7'-10"
			Top Bar	Extension		1'-5"	1'-9"	2'-1"	2'-8"	3'-7"	4'-6"	5'-8"	7'-0"
				Tens Lap - Class C		2'-4"	2'-11"	3'-6"	4'-7"	6'-0"	7'-7"	9'-8"	11'-10"
		Bar Spacing < 6"	General	Extension	Comp	0'-10"	1'-1"	1'-3"	1'-6"	1'-8"	1'-11"	2'-1"	2'-4"
					Tens	1'-6"	1'-11"	2'-3"	3'-0"	3'-11"	4'-11"	6'-3"	7'-8"
				Tens Lap - Class C *		2'-7"	3'-3"	3'-10"	5'-0"	6'-7"	8'-4"	10'-7"	13'-0"
				Comp Lap *		1'-3"	1'-7"	1'-11"	2'-3"	2'-6"	2'-10"	3'-3"	3'-7"
				Lap Enclosed in Spiral		1'-11"	2'-5"	2'-11"	3'-9"	5'-0"	6'-3"	8'-0"	9'-9"
			Top Bar	Extension		1'-9"	2'-2"	2'-7"	3'-4"	4'-5"	5'-7"	7'-1"	8'-8"
				Tens Lap - Class C		2'-11"	3'-8"	4'-5"	5'-8"	7'-6"	9'-6"	12'-0"	14'-9"

* Not for bars enclosed in a spiral
Class A Lap = 59% of Class C Lap
Class B Lap = 77% of Class C Lap

AASHTO LRFD Bridge Design Specifications, 2018

Uncoated Bars **Grade 60**

			Bar Size	#4	#5	#6	#7	#8	#9	#10	#11
			Minimum Clear Cover	1.000 in	1.250 in	1.500 in	1.750 in	2.000 in	2.250 in	2.625 in	2.625 in
			Minimum Bar Spacing (C-C)	2.500 in	3.125 in	3.750 in	4.375 in	5.000 in	5.628 in	6.520 in	6.660 in
f'c = 4000psi	General	Development Length	Comp	0' - 10"	1' - 0"	1' - 3"	1' - 5"	1' - 7"	1' - 10"	2' - 1"	2' - 3"
			Tension	1' - 3"	1' - 6"	1' - 10"	2' - 2"	2' - 5"	2' - 9"	3' - 1"	3' - 7"
		Tension Lap		1' - 7"	2' - 0"	2' - 5"	2' - 9"	3' - 2"	3' - 7"	4' - 0"	4' - 8"
		Compression Lap		1' - 3"	1' - 7"	1' - 11"	2' - 3"	2' - 6"	2' - 10"	3' - 3"	3' - 7"
	Top Bar	Development Length		1' - 7"	2' - 0"	2' - 5"	2' - 9"	3' - 2"	3' - 7"	4' - 0"	4' - 8"
		Tension Lap		2' - 1"	2' - 7"	3' - 1"	3' - 7"	4' - 1"	4' - 8"	5' - 2"	6' - 1"

For Clear Cover or Spacing not meeting the minimums, development and lap lengths will be calculated in Design.

Epoxy Coated Bars w/ Cover ≥ 3db and Clear Bar Spacing ≥ 6db **Grade 60**

			Bar Size	#4	#5	#6	#7	#8	#9	#10	#11
			Minimum Clear Cover	1.500 in	1.875 in	2.250 in	2.625 in	3.000 in	3.384 in	3.810 in	4.230 in
			Minimum Bar Spacing (C-C)	3.500 in	4.375 in	5.250 in	6.125 in	7.000 in	7.896 in	8.890 in	9.870 in
f'c = 4000psi	General	Development Length	Comp	0' - 10"	1' - 0"	1' - 3"	1' - 5"	1' - 7"	1' - 10"	2' - 1"	2' - 3"
			Tension	1' - 6"	1' - 10"	2' - 2"	2' - 7"	2' - 11"	3' - 3"	3' - 8"	4' - 1"
		Tension Lap		1' - 11"	2' - 5"	2' - 10"	3' - 4"	3' - 9"	4' - 3"	4' - 10"	5' - 4"
		Compression Lap		1' - 3"	1' - 7"	1' - 11"	2' - 3"	2' - 6"	2' - 10"	3' - 3"	3' - 7"
	Top Bar	Development Length		1' - 11"	2' - 5"	2' - 10"	3' - 4"	3' - 9"	4' - 3"	4' - 10"	5' - 4"
		Tension Lap		2' - 6"	3' - 1"	3' - 8"	4' - 4"	4' - 11"	5' - 6"	6' - 3"	6' - 11"

For Clear Cover or Spacing not meeting the minimums, development and lap lengths will be calculated in Design.

Epoxy Coated Bars w/ Cover < 3db for Slabs and Approach Slabs **Grade 60**

			Bar Size	#4	#5	#6		#5	#6
			Minimum Clear Cover	1.000 in	1.000 in	1.000 in		1.500 in	1.500 in
			Minimum Bar Spacing (C-C)	2.500 in	2.625 in	2.750 in		3.625 in	3.750 in
f'c = 4000psi	General	Development Length	Comp	0' - 10"	1' - 0"	1' - 3"		1' - 0"	1' - 3"
			Tension	1' - 10"	2' - 9"	3' - 9"		2' - 3"	2' - 9"
		Tension Lap		2' - 5"	3' - 6"	4' - 10"		3' - 0"	3' - 7"
		Compression Lap		1' - 3"	1' - 7"	1' - 11"		1' - 7"	1' - 11"
	Top Bar	Development Length		2' - 1"	3' - 1"	4' - 3"		2' - 7"	3' - 1"
		Tension Lap		2' - 8"	4' - 0"	5' - 6"		3' - 4"	4' - 0"

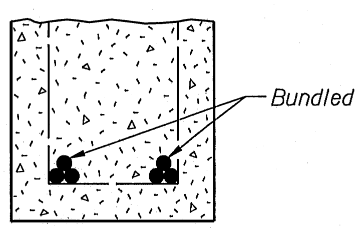
For Clear Cover or Spacing not meeting the minimums, development and lap lengths will be calculated in Design.

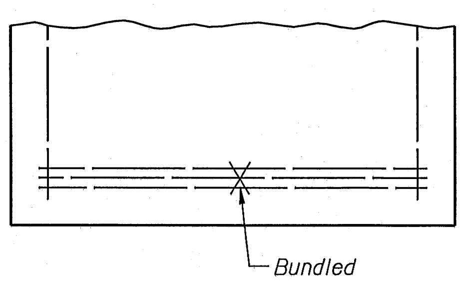
Welded wire fabric shall be selected from the following table.

Common Stock Styles Of Welded Wire Fabric							
Style Designation	Spacing of Wires (in.)		Diameter of Wires (in.)		Sectional Area (in^2 / ft)		Weight (Lbs / 100 ft^2)
	Long.	Trans	Long.	Trans	Long.	Trans	
6 X 6-W1.4 X W1.4	6	6	0.134	0.134	0.028	0.028	21
6 X 6-W2 X W2	6	6	0.160	0.160	0.040	0.040	29
6 X 6-W2.9 X W2.9	6	6	0.192	0.192	0.058	0.058	42
6 X 6-W4 X W4	6	6	0.226	0.226	0.080	0.080	58
4 X 4-W1.4 X W1.4	4	4	0.134	0.134	0.042	0.042	31
4 X 4-W2 X W2	4	4	0.160	0.160	0.060	0.060	43
4 X 4-W2.9 X W2.9	4	4	0.192	0.192	0.087	0.087	62
4 X 4-W4 X W4	4	4	0.226	0.226	0.120	0.120	86

Each structural unit (i.e., abutment, bent, deck, approach slab) uses a numerical **PREFIX** to separate bars in one unit from another. A note is placed on each sheet containing a Bill of Reinforcement identifying the bar prefix. The reinforcing steel fabricator shall prefix each bar in that unit to allow for easy identification of the bars at the job site. Generally, bars are prefixed in the following order: abutments, bents/piers, concrete girders, slab, and approach slabs.

Bundled bars may be used to provide the design steel requirements and should be detailed as follows.





The bar marks, number of bars required, and the bending diagrams for every bar in each structural unit are shown in a **BILL OF REINFORCEMENT** for each structural unit. Example bills are shown towards the end of this section.

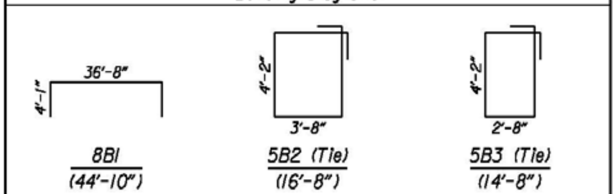
Bars for each location shall be grouped numerically by bar size. Within each bar size, bars shall be listed with bent bars first, straight bars second, and set bars third. Bent bars and set bars shall be listed in ascending numerical order and straight bars shall be listed in ascending lengths. Plain bars, coated bars, and bars not included in the estimated quantity of reinforcing steel shall not be listed separately, but shall be combined within each bar size.

The weight shall be listed either under the location name or at the end of the list at each location. Weight is not required for approach slab bars or any other bars not included in the estimated quantity of reinforcing steel.

BILL OF REINFORCEMENT

Location	Mark	Number Required	
		Bent No. 1	Bent No. 2
Cap	5B2	27	27
	5B3	24	24
	536-6	10	10
	8B1	8	8
	818-6	4	4
	836-6	8	8
	Weight	3152 LB	3152 LB
Columns	4B4	2	2
	813-3	36	36
	Weight	2385 LB	2385 LB
Drilled Shafts	4B5	2	———
	4B6	———	2
	824-10	18	———
	827-10	———	18

Bending Diagrams



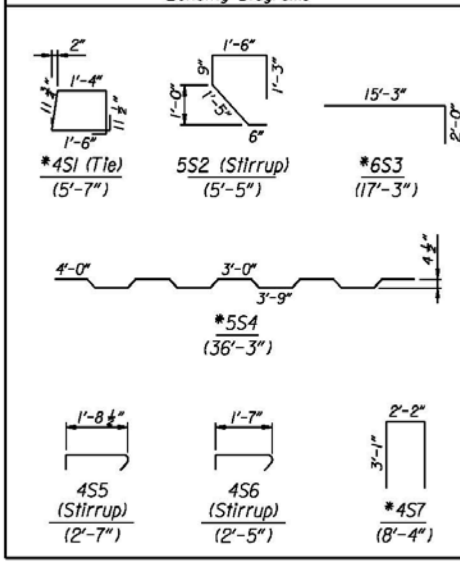
Spirals

Mark	Core	Pitch	Turns
4B4	36"	2 ½"	‡81
4B5	36"	2 ½"	‡107
4B6	36"	2 ½"	‡122

BILL OF REINFORCEMENT

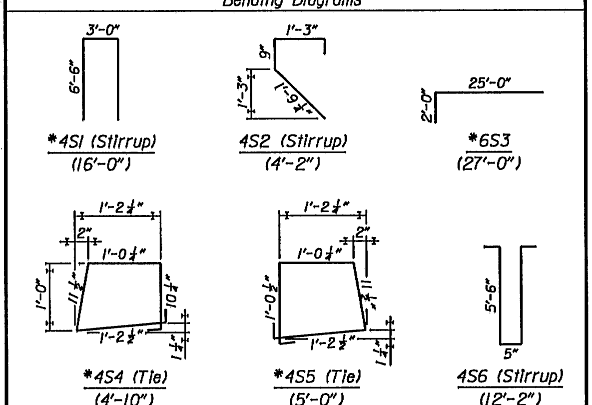
Location	Mark	Number Required
End Diaphragms	4S5	140
	4S6	70
	*4S7	64
	5S2	138
	535-0	16
	*6S3	104
	*Weight	*3051 LB
	Weight	3437 LB
Slab and Curbs	*4S1	130
	*406-4	4
	*437-6	52
	*460-0	4
	*5S4	59
	*507-3	50
	*535-0	120
	*560-0	50
	*635-0	8
	*Weight	*12504 LB

Bending Diagrams

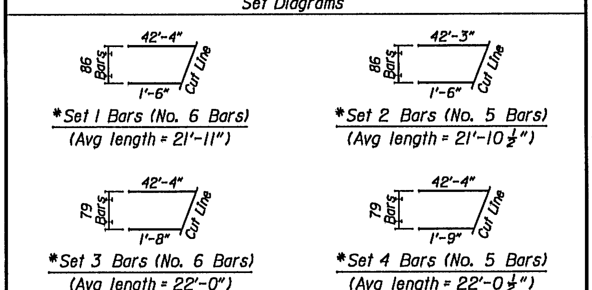


BILL OF REINFORCEMENT			
Location (Weight)		Mark	Number Required
End Diaphragms	Abut No. 1 (*2500 LB) (1046 LB)	*4S1	46
		4S2	62
		504-5	13
		*525-6	13
		560-0	13
		*6S3	41
	Abut No. 2 (*2457 LB) (941 LB)	*4S1	42
		4S2	57
		*525-6	13
		557-8	13
		*6S3	41
Intermediate Diaphragms (1195 LB)		4S6	56
		504-3	10
		508-4	80
Slab (*38614 LB)		*4S4	112
		*4S5	115
		*411-2	41
		*460-0	41
		*542-5	173
		*558-5	59
		*560-0	59
		*Set 2 Bars	1
		*Set 4 Bars	1
		*604-10	4
		*642-5	173
		*657-8	4
		*660-0	4
		*Set 1 Bars	1
		*Set 3 Bars	1
Curbs (*311 LB)		*454-6	2
		*457-11	2
		*460-0	4

Bending Diagrams

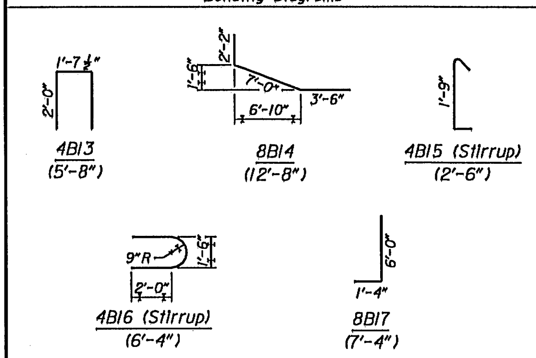


Set Diagrams

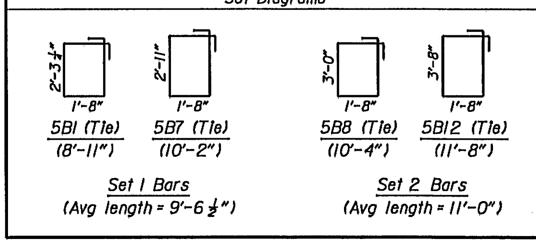


BILL OF REINFORCEMENT		
Location (Weight per Pier)	Mark	Number Required Per Pier
Cap (2332 LB)	4B13	10
	525-8	12
	Set 1 Bars	2
	Set 2 Bars	2
	8B14	16
	812-0	4
	925-8	12
Shaft (4031 LB)	4B15	240
	4B16	40
	410-0	40
	813-0	92
Footing (4410 LB)	706-8	96
	717-8	36
	8B17	92

Bending Diagrams



Set Diagrams



Cells

Name	Description
REBAR	Section View of Rebar
REBARC	C Shaped Rebar
REBARL	L Shaped Rebar
REBARR	Barrier Rail Rebar
REBARU	U Shaped Rebar
REBENT	Bent Rebar
REBEV	Bevel Rebar
REBILL	Bill of Reinforcement
RECANE	Hook Rebar
RECRK4	Crank Rebar for 4 Girders
RECRK5	Crank Rebar for 5 Girders
RECRK6	Crank Rebar for 6 Girders
REHOOK	Hook Rebar with Foot
REPAT	Reinforcing Steel Pattern
RESETB	Set Bent Rebar
RESETS	Straight Rebar Cut Set
RESTPR	R Shaped Stirrup
RESTPU	U Shaped Stirrup
RETYBT	Bent Tie Rebar for Curb
RETYBV	Bevel Tie Rebar for Curb
RETYSQ	Square Tie Rebar