Fabrication and Placement of Reinforcing Steel

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"Chapter 3 - Fabrication and Placement of Reinforcing Steel"

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Chapter 3

Fabrication and Placement of Reinforcing Steel

Topics

1.0.0 Bending Reinforcing Bars

2.0.0 Placing and Tying Reinforcing Steel

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Overview

In recent years, increased concerns about security have refocused the attention of military architects and designers on the elements of structural design and structural integrity. An integral part of increasing building resistance to blasts is the proper use and placement of reinforcing steel.

As a Steelworker, you must be able to properly cut, bend, place, and tie reinforcing steel. This chapter describes the purpose of using reinforcing steel in concrete construction, the shapes of reinforcing steel commonly used, and the techniques and tools used by Steelworkers in rebar (reinforcing steel) work.

Objectives

When you have completed this chapter, you will be able to do the following:

1. Describe the procedures associated with bending reinforcing bars.
2. Describe the procedures for placing and tying reinforcing steel.

Prerequisites

None

This course map shows all of the chapters in Steelworker Advanced. The suggested training order begins at the bottom and proceeds up. Skill levels increase as you advance on the course map.

Welding Costs	↑	STEELWORKER ADVANCED
Metal Fence System		
Fabrication and Placement of Reinforcing Steel		
Layout and Fabrication of Structural Steel and Pipe		
Properties and Uses of Metal		

Features of this Manual

This manual has several features that make it easy to use online.

- Figure and table numbers in the text are italicized. The Figure or table is either next to or below the text that refers to it.
- The first time a glossary term appears in the text, it is bold and italicized. When your cursor crosses over that word or phrase, a popup box displays with the appropriate definition.
- Audio and video clips are included in the text, with an italicized instruction telling you where to click to activate it.

- Review questions that apply to a section are listed under the Test Your Knowledge banner at the end of the section. Select the answer you choose. If the answer is correct, you will be taken to the next section heading. If the answer is incorrect, you will be taken to the area in the chapter where the information is for review. When you have completed your review, select anywhere in that area to return to the review question. Try to answer the question again.
- Review questions are included at the end of this chapter. Select the answer you choose. If the answer is correct, you will be taken to the next question. If the answer is incorrect, you will be taken to the area in the chapter where the information is for review. When you have completed your review, select anywhere in that area to return to the review question. Try to answer the question again.

1.0.0 BENDING REINFORCING BARS

Reinforcing bars often need bending (fabrication) into various shapes to accommodate the stresses in the project's design. Remember, the reason for using reinforcing steel in concrete is to increase the tensile strength of concrete, since concrete's strength is primarily compressive strength.

Compare the hidden action within a beam to breaking a stick over your knee. As you apply force (compression) and your knee pushes toward the middle on one side of the stick, the splinters on the opposite side pull away (tension) from the middle. This is similar to what happens inside a beam.

For illustration, take a simple beam resting freely on two supports near its ends as in *Figure 3-1*. The dead load (weight of the beam itself) causes the beam to bend or sag.

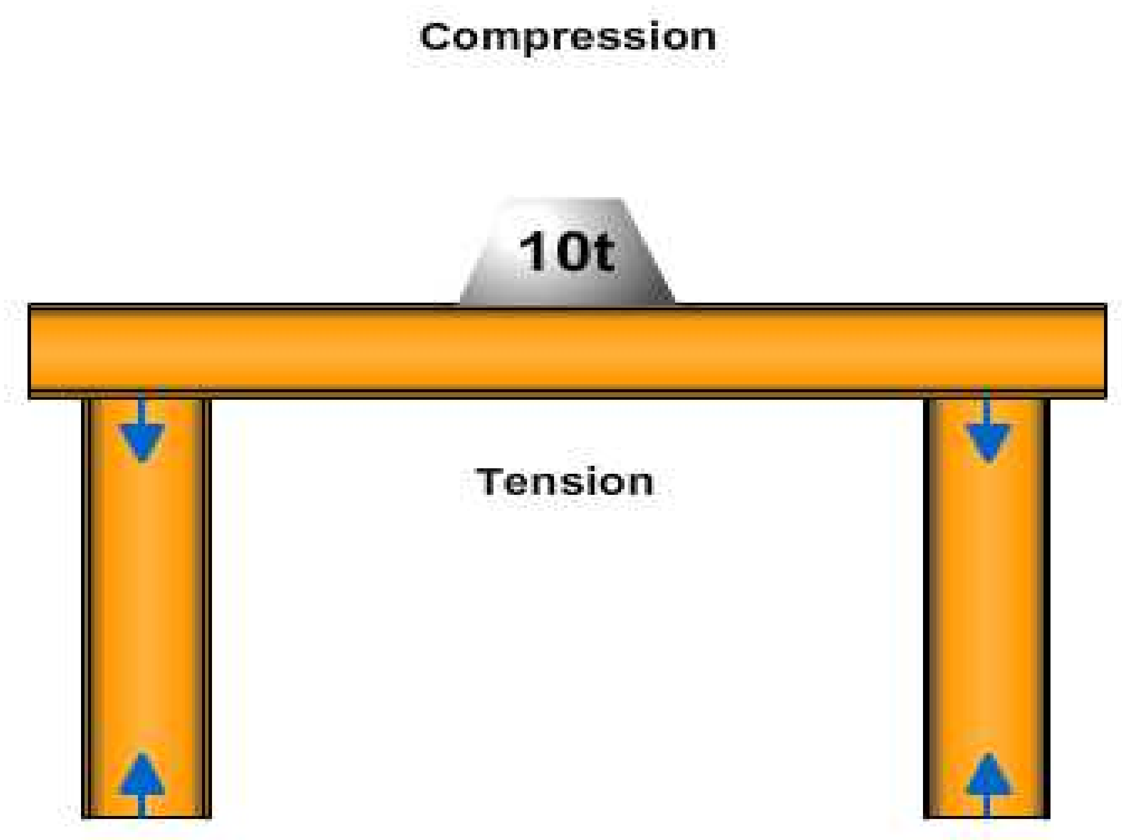


Figure 3-1 — Loading a beam.

Any additional non-permanent load (live load) increases the loading stress (compression) at the top of the beam. From the center of the beam to the bottom of the beam, the forces tend to stretch or lengthen laterally. This part is in tension, and that is where the beam needs the greatest reinforcement.

With the combination of concrete and steel, the tensile strength in the beam resists the force of the loads and keeps the beam from breaking apart. At the exact center of the beam's depth, between the compressive stress and the tensile stress, there is no stress at all—it is neutral (*Figure 3-2*).

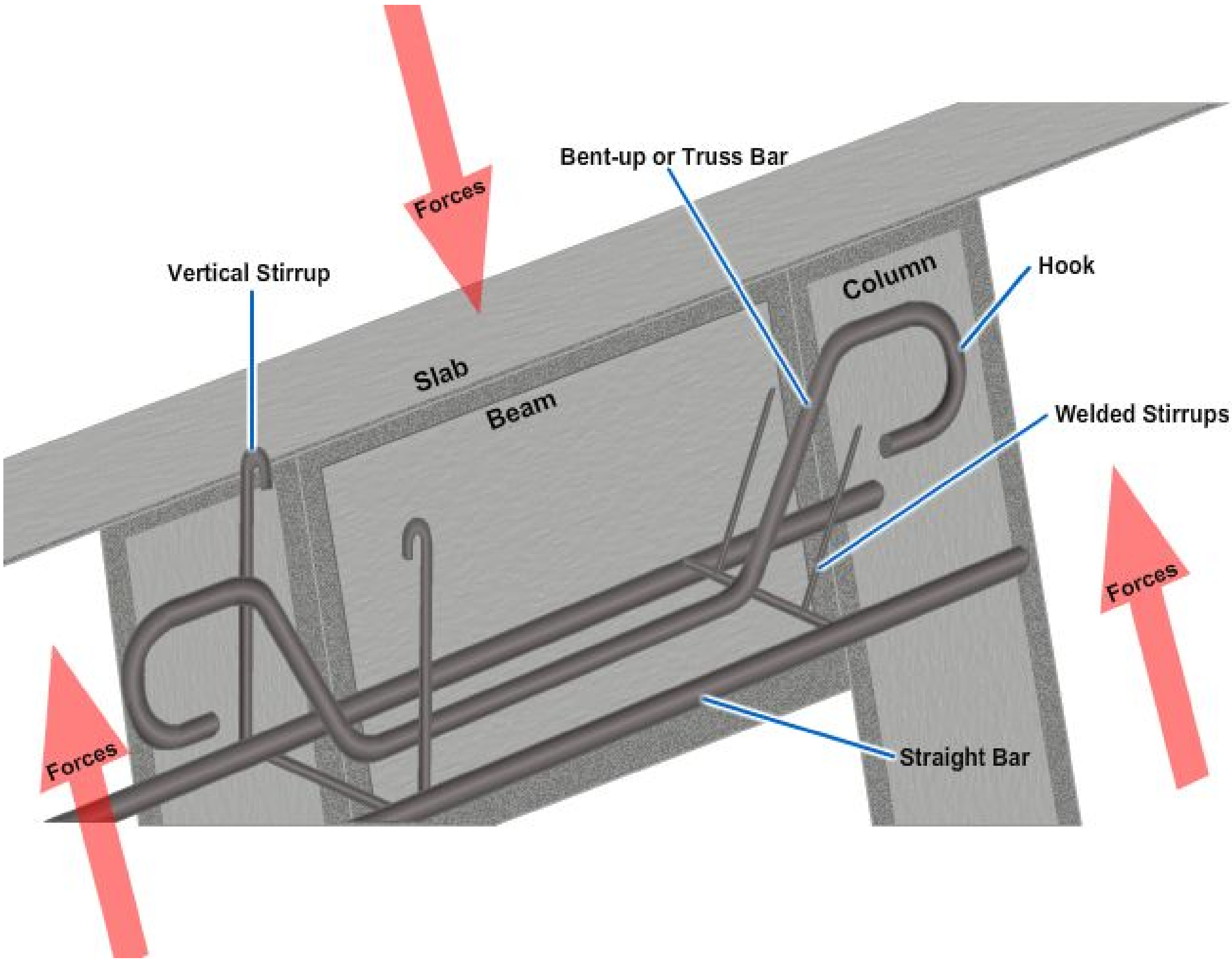
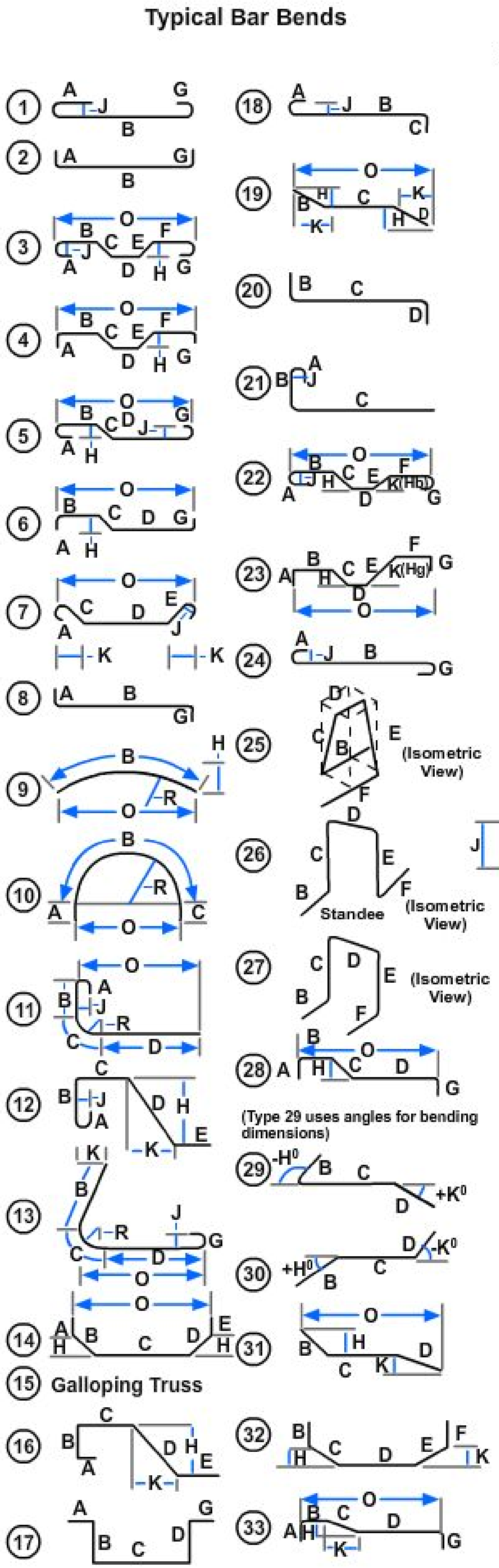
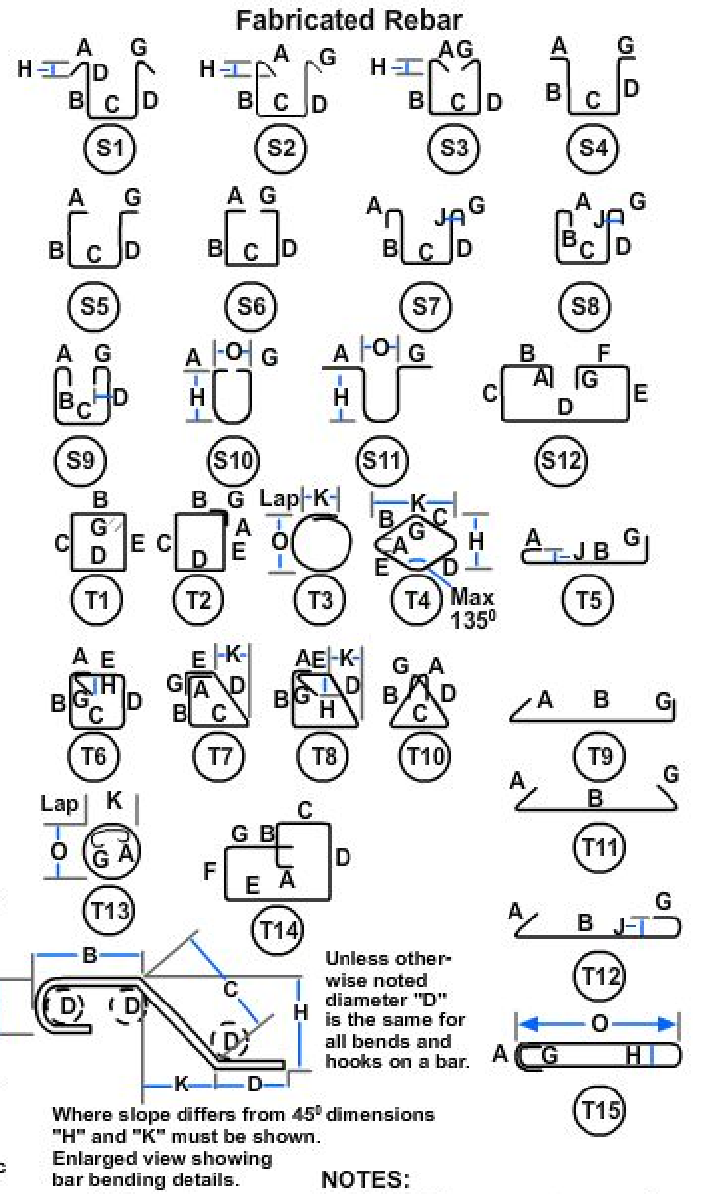


Figure 3-2 — Steel reinforcement in a concrete beam.

In the case of a continuous beam, it is a little different. The top of the beam may be in compression (between columns) along part of its length and in tension along another part (at columns). This is because a continuous beam rests on more than two supports. Thus, the bending of the beam is NOT all in one direction but reversed as it goes over intermediate supports.

To help the concrete resist these stresses, engineers design the bends of reinforcing steel so installers will maximize the placement of additional rebar where the tensile stresses take place. That is why some rebar bends are in an almost zigzag (truss) pattern. *Figure 3-3* shows a standard rebar bending schedule with some typical rebar bends you will encounter. Types, 3, 4, 5, 6, 7, 22, and 23 are all versions of truss bars.





NOTES:

1. All dimensions are out-to-out of bar except "A" and "G" on standard 180⁰ and 135⁰ hooks.
2. "J" dimensions on 180⁰ hooks to be shown only where necessary to restrict hook size, otherwise standard hooks are to be used.
3. Where "J" is not shown, "J" will be kept equal to or less than "H" on truss bars. Where "J" can exceed "H", it should be shown.
4. "H" dimension of stirrups to be shown where necessary to fit within concrete.
5. Where bars are to be bent more accurately than standard bending tolerances, bending dimensions which require closer fabrication should have limits indicated by an * (asterisk).
6. Figures in circles show types.
7. For recommended diameter "D", of bends, hooks, etc., see ACI Standard Hooks tables.
8. Type S1-S12, T1-T14 apply to bar sizes #3 to #8 inclusive only.
9. R (radius dunebsuibs) are to the inside of the bar (types 9, 10, 11, 13).
10. Type 33 does not take bend deduction at the slope dimension "C".
11. Type 12, 14, 16, 19, 22, 23, 29, 30, 31, calculate the bend deduction variably, between 46⁰ and 89⁰.

Figure 3-3 — Typical rebar bends.

The drawings for a job provide all the information necessary for cutting and bending reinforcing bars. Reinforcing steel can be cut to size with shears or with an oxygas cutting torch, and you can also use the cutting torch in the field to make any necessary on-site field adjustments.

If you are fabricating in the field at the jobsite, before bending the reinforcing bars, check and sort for quantity and sizes to be sure you have all you need for the job. Follow the construction drawings when you sort the bars so they will be in the proper order to be bent and placed in the concrete forms. After you have divided the different sizes into piles, label each pile so that you and your crew can find them easily.

You can use a number of types of benders for the job of bending, often just called fabricating, or "fabbing the rebar." Stirrups and column ties are normally No. 3 or No. 4 bar, and you can bend them cold by means of the bending table shown in *Figure 3-4*. *Figure 3-5* shows typical stirrup tie shapes for the stirrups used in beams, shown in *Figure 3-6*. *Figure 3-7* shows column ties in position on a preassembled column prior to setting.

Figure 3-4 — Bending table.

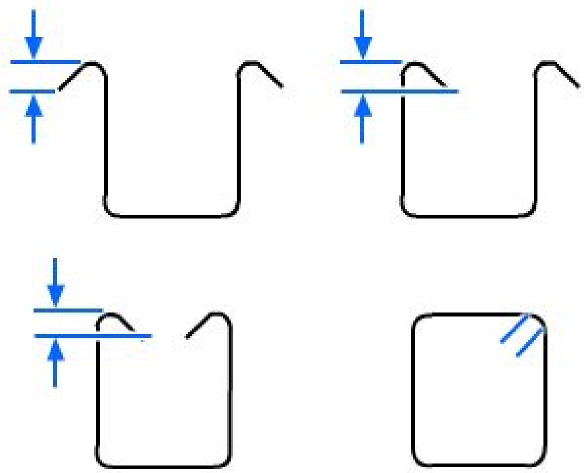


Figure 3-5 — Stirrup tie shapes.

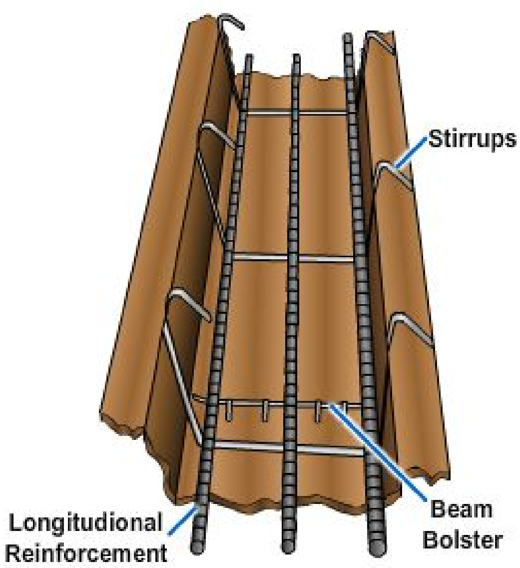


Figure 3-6 — Stirrups in a beam.

Figure 3-7 — Column ties.

When the bars have to be bent in place, a bending tool like the one shown in *Figure 3-8* (in this case, a three-pin hickey), is effective. By placing the jaws of the hickey on one side of the center of the bend and pulling on the handle, you can produce a smooth, circular bend through almost any angle that is desired.

Figure 3-8 — Hickey benders.

1.1.0 Bending Guidelines and Techniques

Make bends, except those for hooks, around pins with a diameter of not less than six times the bar diameter for No. 3 through No. 8 bar (1-inch). If the bar is larger than 1 inch (25.4 mm) (No. 9, No. 10, and No. 11 bar), the minimum pin diameter should be eight times the bar size. For No. 14 and No. 18, the pin diameter should be ten times the diameter of the bar.

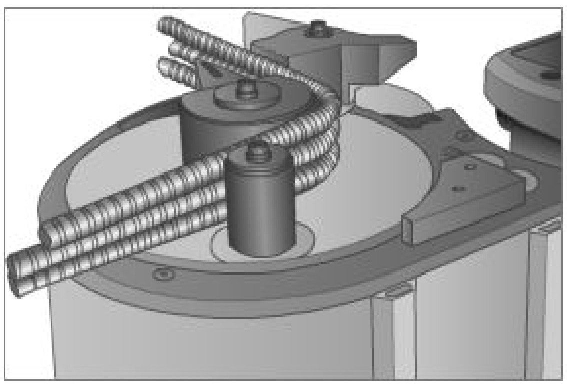
To get smooth, sharp bends when bending large rods, slip a pipe cheater over the rod. This piece of pipe gives you a better hold on the rod itself and makes the whole operation smoother (*Figure 3-9*). You can heat No. 9 bars and larger to a cherry red before bending them, but make sure you do not get them any hotter. If the steel becomes too hot, it will lose strength, become brittle, and can even crack.

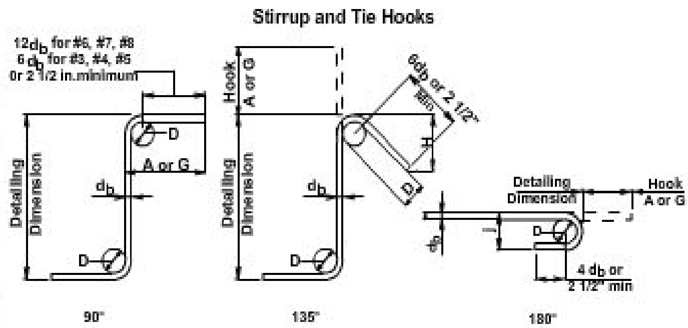
Figure 3-9 — Manual bending.

1.2.0 Bend Diameters

When bending reinforcing bars, benders in the field or fabricators in the shop must exercise caution to ensure the bends are not too sharp. Rebar may crack or weaken if bent too sharply. The American Concrete Institute (ACI 318 Building Code Requirements for Structural Concrete) has established minimum bend diameters for the different bar sizes and for the various types of hooks.

There are many different types of bends, depending on how the rods are to be used. For example, there are hooks for the ends of heavy beams and girders, offset bends for vertical column splices at or near floor levels, beam stirrups, column ties, slab reinforcement, and spiral for round columns or foundation caissons. These bending details are shown in *Figure 3-10.*





Stirrup and Tie Hook Dimensions, in.				
Bar Size	D, in.	90 - Deg Hook	135 - Deg Hook	
		A or G	A or G	H, Approx
#3	1 1/2	4	4	2 1/2
#4	2	4 1/2	4 1/2	3
#5	2 1/2	6	5 1/2	3 3/4
#6	4 1/2	1-0	7 3/4	
#7	5 1/4	1-2	9	5 1/4
#8	6	1-4	10 1/4	6

Figure 3-10 — Multiple bends and bending details.

To save yourself some time and extra work, try to make all bends of one kind at one time instead of continuously measuring and setting the templates on your bending block for different bends.

1.3.0 Reinforcing Steel (RST) Bending and Cutting Equipment

RST bending and cutting equipment ranges from a simple leverage bar to a 10,000-pound electro-hydraulic rebar fabricator capable of bending and cutting # 18 rebar. As a Steelworker, you will normally be bending rebar in the field. Most of the tools you will be working with will be portable. The following are some of the tools and machines you may be using in the field.

Leverage bar — also known as a hickey, this bar is comprised of a long handle and a jaw mechanism to hold on to the rebar and impart a bend in it.

Manual cutter and bender —normally attached to a length of 2 x 6, it has a leverage bar and a rebar cutter. The rebar cutter head is very similar to a bolt cutter (*Figure 3-11*).

On some small projects, such as minor building foundations, curb installations, or similar jobs with minimal but necessary rebar requirements, often contractors will use the combination cutting and bending tool like the one shown.

Figure 3-11 — Manual cutter and bender.

A hand-held electric/hydraulic bender and cutter (*Figure 3-12*) and hand-held chop saw (*Figure 3-13*) are used for in-place bending and cutting rebar.

Figure 3-12 — Hand-held cutter and bender.

Figure 3-13 — Hand-held chop saw.

A portable table rebar cutter and bender is used for high volume repetitious bends before the rebar is placed into the concrete (*Figure 3-14*). It has a lever or knob type of angle selector for consistent bends.

Figure 3-14 — Table cutter and bender.

1.4.0 Standard Hook Bending

Using an electric or hydraulic rebar bender to bend reinforced steel bars can save you a lot of time and physical effort during the construction process. Learning how to use a rebar bender can be an easy process once you follow a few simple instructions and follow some key safety guidelines.

Rebar bending machines come in a variety of pressure output specifications and bending angle capabilities. Make sure that you choose the correct bender for the thickness of the rebar you are trying to bend and the angle you need to achieve. If you have an electrically powered bender, make sure you have the correct electrical connections available for the machine. Bender operation is typically conducted through easy-to-use foot pedals that ensure that you have both hands free to manipulate the rebar during the bending process. Foot pedals also enable you to step away from the machine and halt operation instantly in case of emergencies.

Most common bending machines will come with a variety of bending rollers. Be sure you use the correct set to meet the thickness of the rebar you are going to bend, and use the adjustment knob to adjust the bending angle for the angle desired. The adjustment knobs can typically manipulate rebar from angles of 1 degree to 180 degrees or more.

Always wear protective gloves while handling the rebar. After you have put on your gloves, lift the rebar and place it into the feeding slot of the machine. Note that some machines allow you to bend multiple pieces of rebar simultaneously. However, if you are using the machine for the first time, start with one bar at a time to gain familiarity with the machine's operation, and prevent alignment and handling issues. Use a firm grip on the rebar and stand in a position that allows you to quickly move away from the machine in case of a safety concern.

The foot pedals will allow you to activate the machine once the rebar is in place. On certain models, an electronic interlocking system may not allow you to activate the machine until certain safety prerequisites are met.

The hydraulic mechanism will engage and start the bending process. You need to be very alert at this point to ensure that your hand is placed out of harm's reach as the roller bends the rebar.

Once the bending process has ended, keep clear of the foot pedals and remove the rebar from the machine. In many cases, you may need to add a second bend to the same rebar, in which case you can repeat the process as desired.

Your speed and efficiency of using the bender will improve as you practice using the machine a few times.

1.5.0 Multiple Bending

Bending multiple reinforcement bars is accomplished the same way as standard hook bending, simply by placing the bars in the machine one on top of the other (*Figure 3-15*). The size limitations of the rebar will be stated in the operator's manual. Do not exceed the rated capacity of the machine, or possible personal injury or damage to the machine may occur.

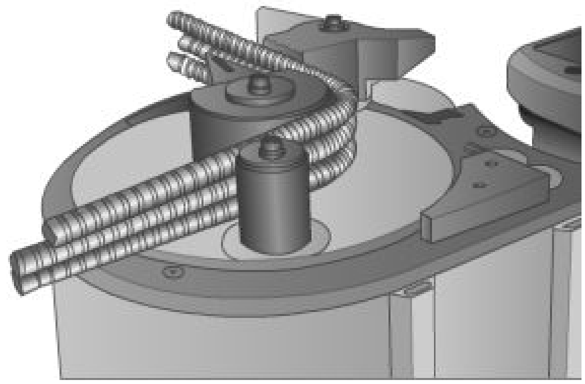


Figure 3-15 — Multiple bars.

2.0.0 PLACING and TYING REINFORCING STEEL

Before you place rebar in a form, ensure the form oiling has already been done. Oiling the form after the rebar is in place may allow some of the oil to get on the rebar, which will interfere with the concrete bonding process. Use a piece of burlap to remove rust, loose mill scale, grease, mud, or other foreign matter from the bars. However, a light film of rust or mill scale is acceptable and in fact preferable.

During the bending process, you need to mark the reinforcing bars to indicate where they will be located in the project and fit into a particular assembly. You may work according to either one of the two most often used systems for marking bars; however, the system you use needs to agree with the marking system on the engineering or assembly drawings. The two marking systems used are as follows:

1. All bars in one type of member are given the mark of that member. This system is used for column bars, beam bars, footing bars, and so on.
2. The bars are marked in greater detail. These marks show exactly where the bar is to be placed. In addition to the type member (that is, beam (B), wall (W), column (C), and so on), the marks show the floor on which the bars are to be placed and the size and individual number of each particular bar. Instead of showing the bar size by its diameter measurement, the mark shows the bar size in code by eighths. The examples shown below show the second type of marking system.

   - Tag 2B805
     - 2 = second floor
     - B = beam member
     - 8 = 8/8- or 1-inch (2.5 cm)-square bar
     - 05 = part of the second floor plan designated by the number 5
   - Tag 2B0605
     - 2 = second floor
     - B = beam member

- o 06 = 6/8- or 3/4-inch (1.9 cm)-round bar
- o 05 = part of second floor plan designated by the number 5

2.1.0 Types of Ties

Tie wire is used to hold rebar in place to ensure that when concrete is placed the bars do not shift out of position. Typically, 16-gauge wire is used to tie reinforcing bars, although in the civilian industries 15-gauge wire is commonly used and on rare occasion 14-gauge wire is used for special circumstances. About 12 pounds (5.4 kg) of 16-gauge wire is required to tie an average ton (0.9 tonne) of bars.

NOTE

Tie wire adds nothing to the strength of the steel.

The tie wire may come in large rolls (shoulder coils) where installers cut smaller sections off and roll it around the neck and shoulders as they use the wire. However, in today's civilian industry where Ironworkers place the rebar, tie wire reels affixed to belts are the common method of distributing the wire. On small projects when only snap ties are necessary, another alternative is looped end tie wires (*Figure 3-16*).

Figure 3-16 — Wire ties and tools.

Installers use a number of different tie configurations to join rebar together and hold it in the proper spacing and in place as the concrete pours. Each has its particular situational use, such as for speed, climbing, or twist prevention. *Figure 3-17* shows six types of ties; below, they are identified according to the letters of the alphabet with characteristics identifying their particular use.

A. Snap tie or simple tie. The wire is simply wrapped once around the two crossing bars in a diagonal manner with the two ends on top. These are twisted together with a pair of sidecutters until they are very tight against the bars. Then the loose ends of the wire are cut off. This tie is used mostly on floor slabs.

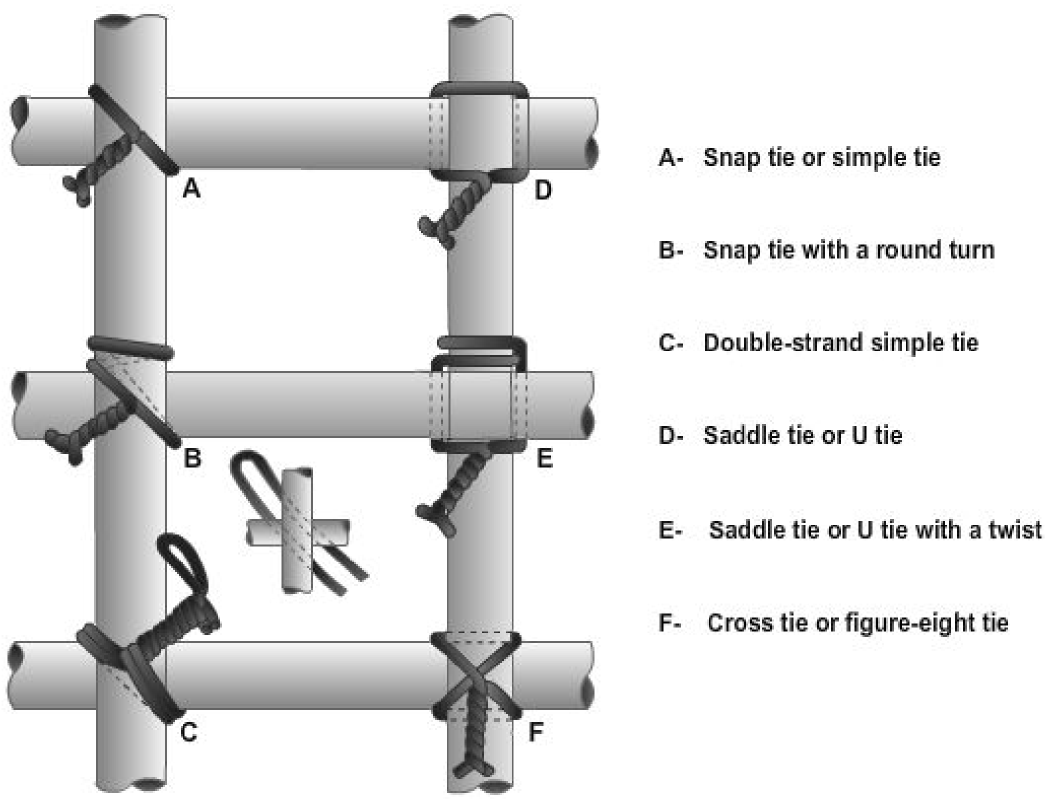


Figure 3-17 — Types of ties.

B. Snap tie with a round turn or wall tie. This tie is made by going about 1 1/2 times around the vertical bar, then diagonally around the intersection, twisting the two ends together until the connection is tight, but without breaking the tie wire, then cutting off the excess. The wall tie is used on light vertical mats of steel.

C. Double-strand simple tie. This tie is a variation of the simple tie. It is especially favored for heavy work.

D. Saddle or U tie. The wires pass halfway around one of the bars on either side of the crossing bar and are brought squarely or diagonally around the crossing bar with the ends twisted together and cut off. This tie is used on special locations, such as on walls.

E. Saddle or U tie with a twist. This tie is a variation of the saddle tie. The tie wire is carried completely around one of the bars, then squarely across and halfway around the other, either side of the crossing bars, and finally brought together and twisted either squarely or diagonally across. The saddle tie with twist is used for heavy mats that are to be lifted by a crane.

F. Cross tie or figure eight tie. This type of tie has the advantage of causing little or no twist in the bars.

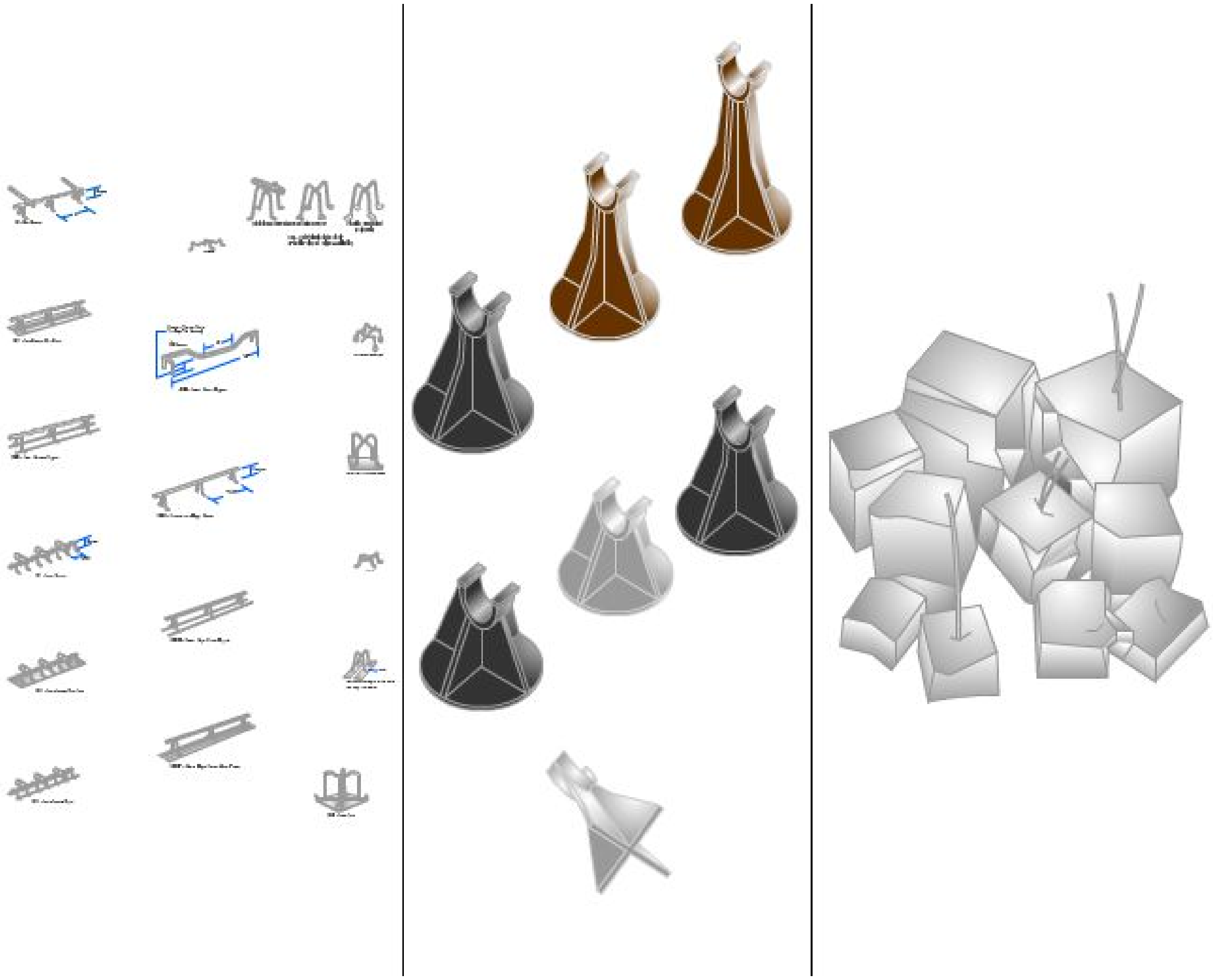


Figure 3-18 — Slab reinforcement bar supports.

The proper location for the reinforcing bars is usually given on drawings. In order for the structure to withstand the loads it must carry, the steel must be placed as shown in the drawings. Secure the bars in position in such a way that concrete-placing operations will not move them. This can be accomplished by the use of the reinforcing bar supports shown in *Figures 3-18* (chairs and bolsters), *3-19* (concrete blocks or "dobies"), *and 3-20* (tie wire and temporary supports).

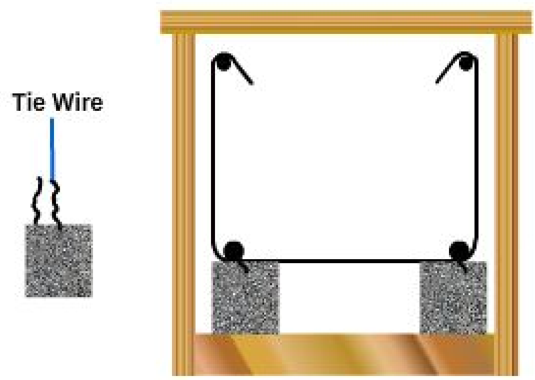


Figure 3-19 — Ties using concrete block.

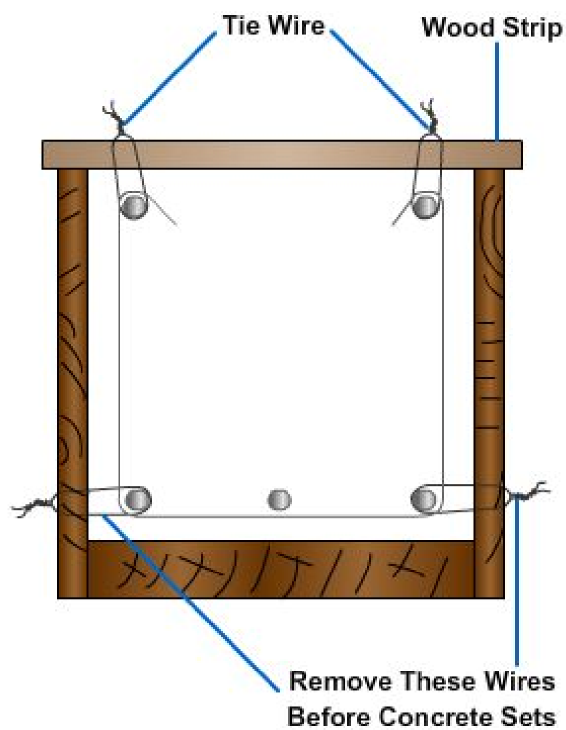


Figure 3-20 — Ties in a wooden form.

2.2.0 Minimum Concrete Coverage

The proper coverage of bars in the concrete is very important to protect the bars from fire hazards, possibility of corrosion, and exposure to weather. The American Concrete Institute's ACI 318 publication *Building Code Requirements for Structural Concrete and Commentary* provides standards for minimal concrete coverage. When unspecified, follow the minimum standards given below and in *Figure 3-21.*

1. Footings — 3 inches at the sides and on the bottoms of footings or other principal structural members where concrete is deposited on the ground.
2. Walls — 2 inches for bars larger than No. 5, where concrete surfaces, after removal of forms, would be exposed to the weather or be in contact with the ground; 1 1/2 inches for No. 5 bars and smaller; 3/4 inch from the faces of all walls not exposed directly to the ground or the weather.
3. Columns — 1 1/2 inches over spirals and ties.
4. Beams and girders — 1 1/2 inches to the nearest bars on the top, bottom, and sides.
5. Joists and slabs — 3/4 inch on the top, bottom, and sides of joists and on the top and the bottom of slabs where concrete surfaces are not exposed directly to the ground or the weather.

NOTE

All measurements are from the outside of the bar to the face of the concrete, NOT from the main steel, unless otherwise specified.

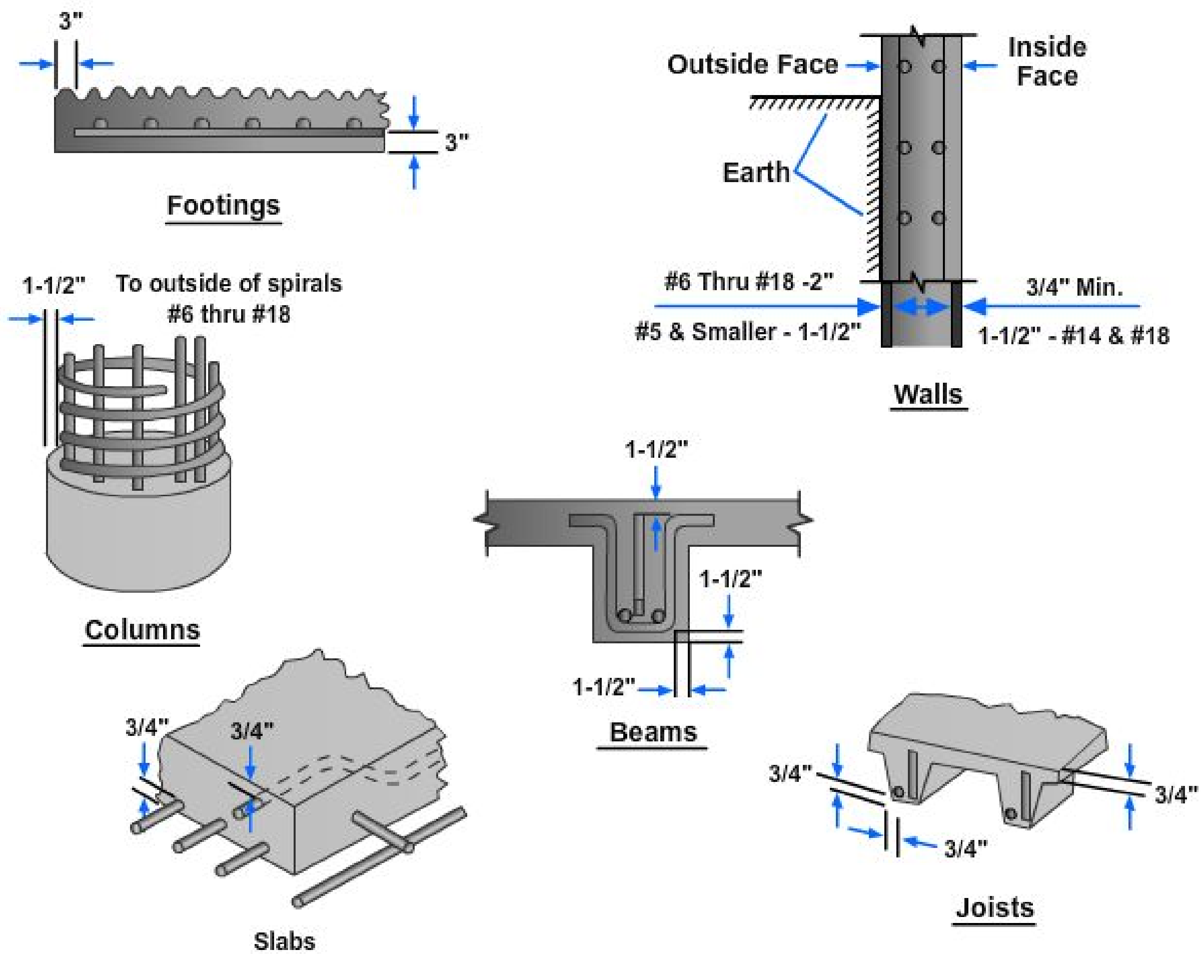


Figure 3-21 — Minimum coverage of rebar in concrete.

Reinforcing bars are in tension and therefore should never be bent around an inside corner. They can pull straight through the concrete cover. Instead, they should overlap and extend to the far face for anchorage with 180-degree hooks and proper concrete coverage (*Figure 3-22*).

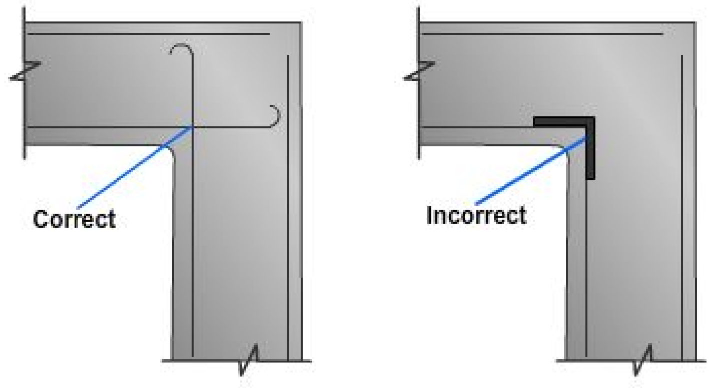


Figure 3-22 — Correct and incorrect placement.

Splices are sometimes needed to complete a reinforcement project. Where splices in reinforcing steel are not dimensioned on the drawings, the bars should be lapped not less than 30 times the bar diameter nor less than 12 inches (*Table 3-1*). The stress in a tension bar can be transmitted through the concrete and into another adjoining bar by a lap splice of proper length. If you cannot lap the splices, you need to use mechanical butt splices.

NOTE

Lap splicing is prohibited in reinforcement bars sizes #14 and #18. Adhere strictly to the ACI 318 Building Code in all matters of reinforcement bar splicing.

Table 3-1 — Length of Lap Splices in Reinforcing Bars.

INCHES OF LAP CORRESPONDING TO NUMBER OF BAR DIAMETERS*											
Number of Diameters	**Size of Bars**										
	#3	**#4**	**#5**	**#6**	**#7**	**#8**	**#9**	**#10**	**#11**	**#14**	**#18**
30	12	15	19	23	27	30	34	39	43	**Prohibited by ACI 318**	
32	12	16	20	24	28	32	36	41	45		
34	13	17	22	26	30	34	39	44	48		
36	14	18	23	27	32	36	41	46	51		
38	15	19	24	29	34	38	43	49	54		
40	15	20	25	30	35	40	46	51	57		
Minimum lap equals 12 inches!											
* Figured to the next larger whole inch											

If you are authorized to use lap splices, consider the following guidelines:

1. Grade of steel: the higher the yield stress, the greater the lap length.
2. Surface condition of the bar: epoxy-coated bars require up to 50% longer laps than black bars.
3. Size of the bars: the larger the bar, the longer the lap.
4. Grade of concrete: the lower the concrete strength, the longer the lap required.
5. Location of the splice: efficiency is dependent on bar location, position in the structural member, edge conditions, and spacing.
6. Design load: the lap length required for bars in tension is much longer than for the same size bars in compression. A lap design for compression load will not perform as a full tension splice. In the event of unanticipated forces to a structure, lap splices may fail.

To lap WWF (weld wire fabric/wire mesh), you can use a number of methods, two of which are the end lap and the side lap. In the end lap method, the wire mesh is lapped by overlapping one full mesh, measured from the ends of the longitudinal wires in one piece to the ends of the longitudinal wires in the adjacent piece, and then tying the two pieces at 1-foot 6-inch (45.0 cm) centers with a snap tie. This method saves some material, but costs in time and labor since the corners of the squares do not meet and require additional tying. In the side lap method, the two longitudinal side wires are placed one alongside and overlapping the other and then are tied with a snap tie every 3 feet (.9 m). In this method, the corners of the squares always overlap and align, thus requiring less tying and lowering labor production time and costs.

You can splice reinforcing bars by metal arc welding, but only if called for in the plans and specifications, and you use a welder certified to weld rebar. For bars placed in a vertical position, a butt weld is preferred. The end of the bottom bar is cut square, and the end of the top bar resting on it is cut in a bevel fashion, thus permitting a butt weld. For bars that will bear a load in a horizontal position, a fillet weld is preferred. Usually, the two bars are placed end to end with pieces of flat bar (or angle iron) placed on either side. Fillet welds are then made where the metals join. The welds are made to a depth of one-half of the bar diameter and for a length eight times the bar diameter.

Unless you are lapping bars, you need to maintain distances between bars to achieve the designed concrete bonding. The minimum clear distance between parallel bars in beams, footings, walls, and floor slabs should be either 1 inch (25.4 mm) or 1 1/3 times the largest size aggregate particle in the concrete, whichever distance is greater. In columns, the clear distance between parallel bars should be not less than 1 1/2 times the bar diameter or 1 1/2 times the maximum size of the coarse aggregate; always use the larger of the two.

The support for reinforcing steel in floor slabs is shown in *Figure 3-23*. The required concrete protective cover determines the height of the slab bolster. Concrete blocks made of sand-cement mortar can be used in place of the slab bolster unless the plans and specs prohibit it for architectural reasons; never use wood blocks. You can obtain highchairs (*Figure 3-18*) in heights up to 6 inches (15 cm), or when a height greater than 6 inches is required, you can make the chair out of No. 0, soft, annealed iron wire. To hold the bars firmly in position, tie the bars with a snap tie at frequent intervals where they cross.

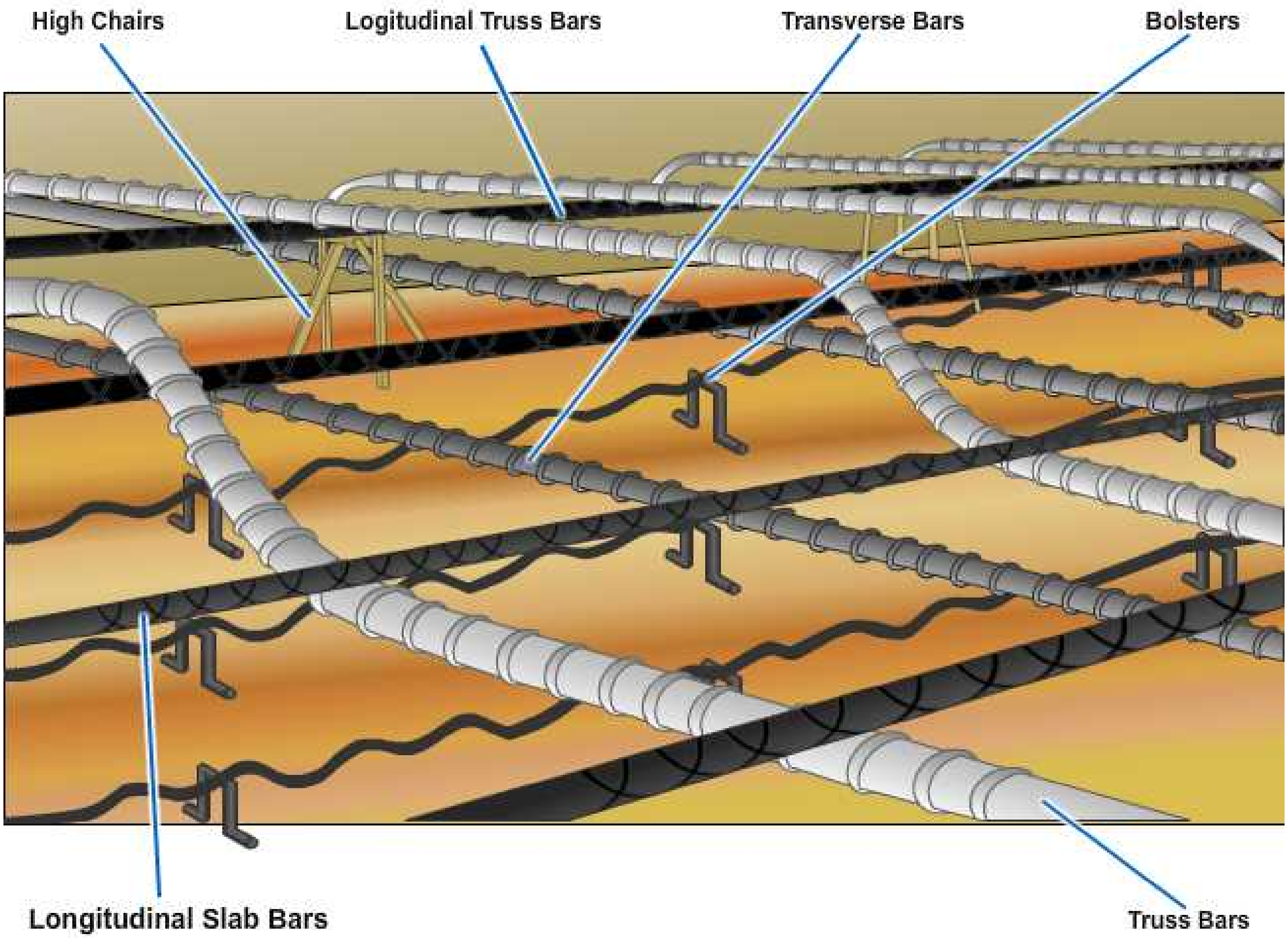


Figure 3-23 — Floor slab reinforcement bar placement.

You can pre-assemble the rebar for columns by tying the vertical bars and ties into cages by laying the vertical bars for one side of the column horizontally across a couple of sawhorses. Then place and tie the proper number of ties at the spacing required by the plans and add the remaining vertical bars. Tie wire all intersections together to make the assembly rigid so that it can be hoisted and set as a unit. *Figure 3-24* shows a typical column tie assembly set in place and spliced to the lower floor's dowels.

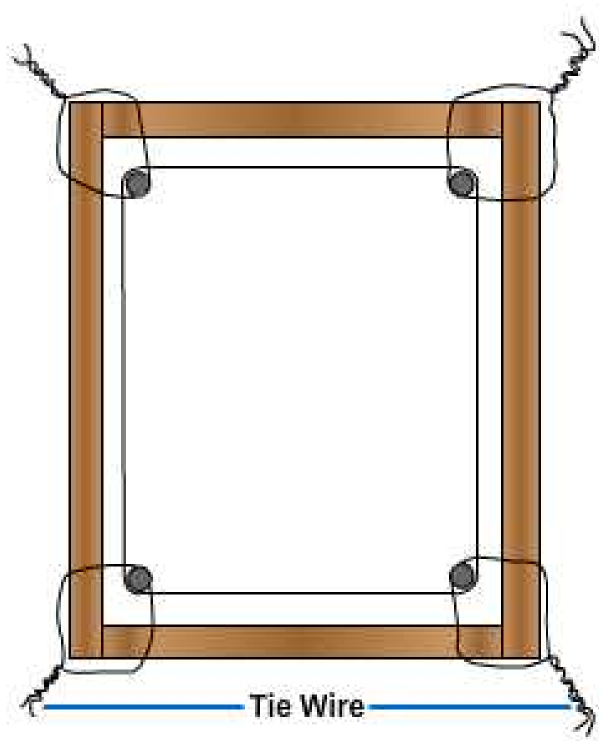


Figure 3-24 — Reinforcement bar column.

After the column is raised, it is tied to the dowels or reinforcing steel carried up from below. This holds it firmly in position at the base. Typically, concrete blocks (dobies) are tied to the column to maintain clearances, and the column form is erected and set in place. If dobies are not available and the rebar column is relatively light, it can be tied to the column form at 5-foot (4.5-m) intervals, as shown in *Figure 3-25*. The trouble with the latter system is the wires protruding from the forms. They must be watched and removed after the concrete is poured but before it sets, or removed after the form is stripped, thus leaving the ends exposed to promote rust.

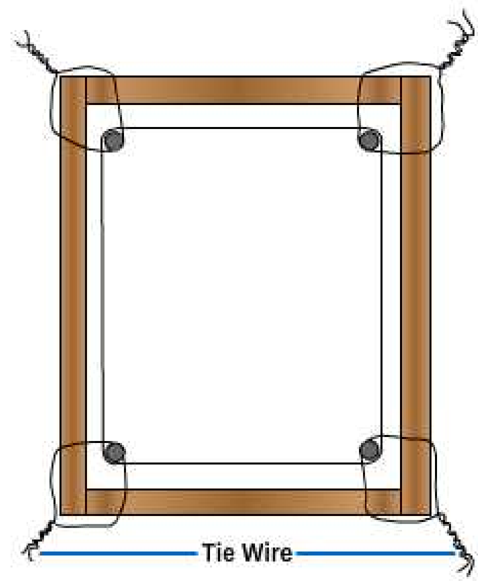


Figure 3-25 — Method of holding column steel on plane in formwork.

Refer again to *Figure 3-6* for the use of metal supports to hold beam reinforcing in position. Note the position of the beam bolster. The stirrups are tied to the main reinforcing steel with a snap tie. However, while the beam schedule may require only the bars that are illustrated (three in the bottom with the upper bars unplaced yet), practical experience will quickly demonstrate that there is nothing to keep the stirrups from falling over. Often the installer will add a “giveaway” bar, usually a #4, up the side of the stirrups but below bottom slab height, just to keep them in place with their tops at a common elevation. Wherever possible, assemble the stirrups and main reinforcing steel outside the form, and then place the assembled unit in position. Precast concrete blocks or plastic spacers, as shown in *Figure 3-18*, may be substituted for metal supports.

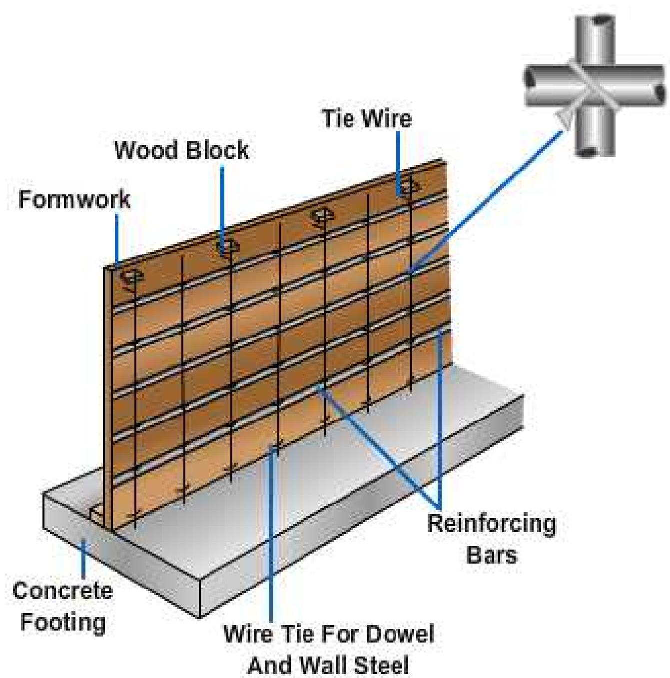


Figure 3-26 — Reinforcement steel on a wall form.

Steel in place on a wall is shown in *Figure 3-26*. The wood block is removed when the form has been filled up to the level of the block. For high walls, ties in between the top and bottom should be used (*Figure 3-27*).

The horizontal and vertical bars are wired securely to each other at sufficiently frequent intervals to make a rigid mat. Tying is required at every second or third intersection, depending upon the size and spacing of bars, but with not less than three ties to any one bar, and, in any case, not more than 4 to 6 feet apart in either direction.

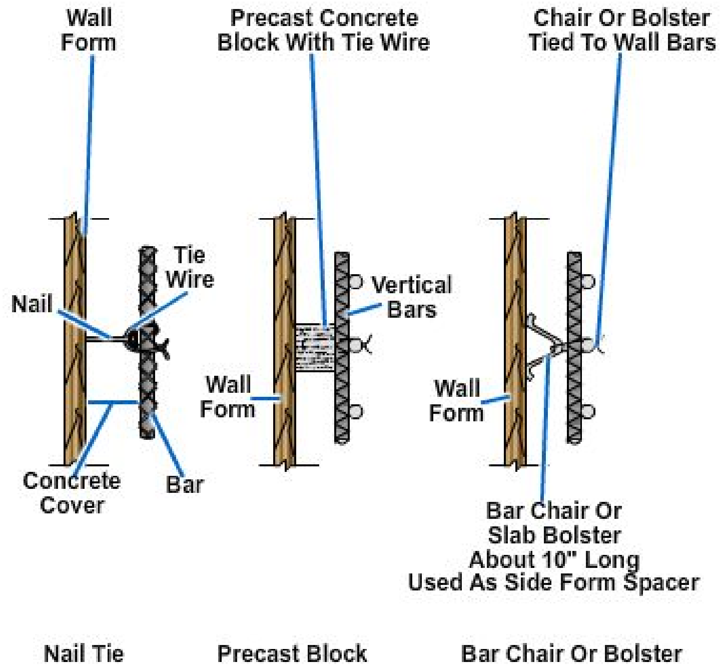


Figure 3-27 — Reinforcement steel supports in a wall.

Rebar is placed in footings very much as it is placed in floor slabs. Typically, dobies, rather than steel supports, are used to support the steel at the proper distance above the subgrade. Rebar mats in small footings (*Figure 3-28)* are generally preassembled and placed after the forms have been set, while mats in large footings (*Figure 3-29*) are constructed in place.

Figure 3-28 — Reinforcement steel in a slab.

Figure 3-29 — Large floor slab.

Summary

This chapter discussed how to properly cut, bend, place, and tie reinforcing steel. It also described the purpose of using reinforcing steel in concrete construction, the shapes of reinforcing steel commonly used, and the techniques and tools used by steelworkers in rebar (reinforcing steel) work. As always, use the manufacturer's operator manuals for the specific setup and safety procedures of the equipment you will be using, and wear the proper personal protective equipment.

Additional Resources and References

This chapter is intended to present thorough resources for task training. The following reference works are suggested for further study. This is optional material for continued education rather than for task training.

ACI 318-05 Building Code Requirements for Reinforced Concrete, American Concrete Institute, Detroit MI, 2004.

Concrete Construction Engineering, 2nd ed. Nawy, E.G. Boca Raton, FL, 2008

Concrete and Masonry, FM 5-428, Headquarters Department of the Army, Washington, DC, 1998.

Consolidated *Cross-Reference, TA-13,* Department of the Navy, Navy Facilities Engineering Command, Alexandria, VA, 1989.

Construction Print Reading in the Field, TM 5-704, Headquarters Department of the Army, Washington, DC, 1969.

*Placing Reinforcing Bars, 8*th ed., Concrete Reinforcing Steel Institute, Schaumburg, IL, 2005.