Rigging Knots

By Sharon Lilly, Ken Palmer, and Rip Tompkins

It seems as though new knots are introduced into arboriculture every year. Some seem redundant to traditional knots already in use. Others offer immediate advantages, given the application and choice of rope. Each has its limitations, though, and it is important to know what those limitations are when selecting a knot to use for each application and with each rope type. Under demanding situations, choosing the correct knot can improve the strength of the system and make it possible to untie the ropes when finished. Unfortunately, an inappropriate choice can lead to failure of the system and may have dire consequences. Knowing the correct way to tie a variety of knots, and understanding the advantages and limitations of each, is a critical skill for the rigger.

Parts of a Line

In describing how to tie a knot, it is useful to have some standard terminology to refer to parts of a line (Figure 1). Sections along the length of a rope can be described two ways: relative to the rope itself or relative to a rigging point. For the first case, a rope has a working end and a running end, or the ends in use and not in use, respectively. Anything not in use in between is the standing part. In the second case, anything from the rigging point to the working end is the lead of the rope, and the part from the rigging point to the running end is the fall (Figure 2). Additionally, there are terms to describe the steps in tying a knot:

- Bight: A bight is an uncrossed curve or arc in the active part of a rope between the working end and the standing part.
- Loop: A crossed bight is called a loop.
- Turn: A loop around an object is called a turn.
- Round turn: Two loops around an object is a round turn.

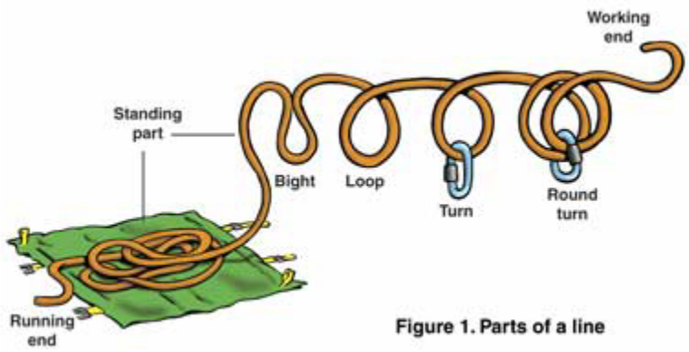


Figure 1. Parts of a line

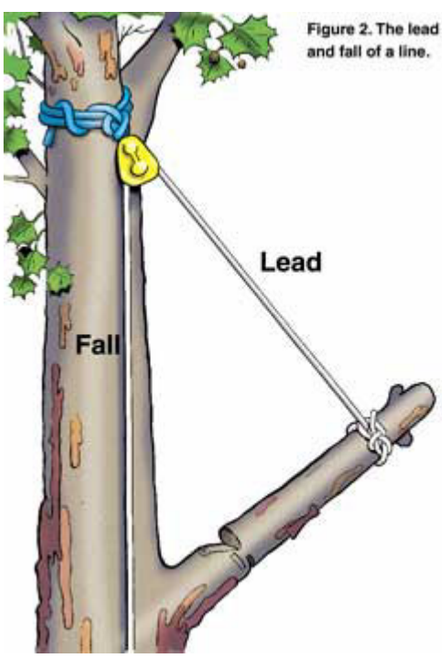


Figure 2. The lead and fall of a line.

Knots

Even the word "knot" can be unclear. It is a general term given to all knots, hitches, and bends, although each term represents a subgroup.

- Loop: A loop can be made fast with a knot. A loop can be at the end of a line (an endline loop) or in the bight (a midline loop).
- Hitch: A hitch is made when a rope is secured around an object or its own standing part.
- Bend: A bend is a type of knot that secures two ends to each other. A bend formed with two ends of the same line forms a fixed loop.

Tie, Dress, and Set (T.D.S.)

With any knot employed, it is important to

- T—tie
- D—dress (align the parts)
- S—set (tighten the knot or make ready for use)

This procedure ensures that the knot is tied completely and properly and is ready for use.

Common Knots Used in Rigging

Bowline

One of the most commonly used knots in arboricultural rigging is the common bowline (Figure 3). It is a useful knot for forming a loop, and it is easy to untie, even after loading. The bowline is the basis for other knots in the "bowline family" (running bowline, bowline on a bight, sheet bend, double bowline).

To tie: Start with a counterclockwise turn in the rope, with the working end passing in front of the standing part. Pass the working end up through the turn, counterclockwise behind the standing part, and down through the turn. To set the knot, tighten the turn and the bight formed by the working end.

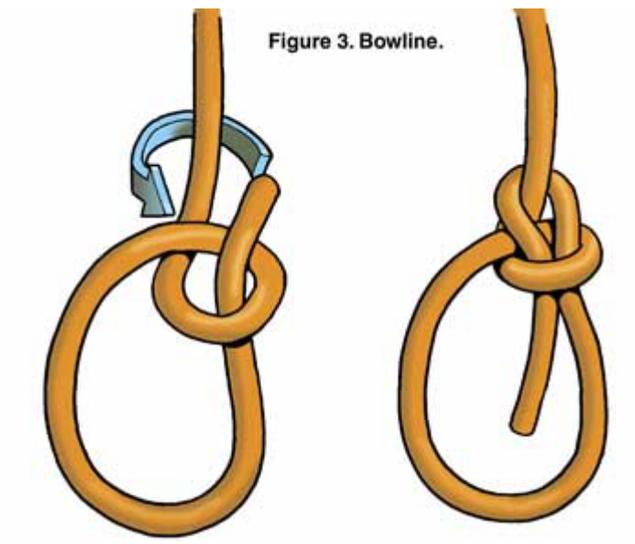


Figure 3. Bowline.

Running Bowline

A variation on the bowline, the running bowline (Figure 4) often is used in tying off limbs. It functions as a slip knot and can be "run up" the line. Like the bowline, it is easy to untie after loading.

To tie: A running bowline is tied by forming the loop of the bowline around the standing part of the line, in effect forming a type of lasso (the true lasso is made with a honda knot).

Figure 4. Running bowline.

Bowline on a Bight

The bowline on a bight (Figure 5) is still widely taught, although it is not frequently used. It forms two loops and can be used as a makeshift saddle in an emergency.

To tie: In the middle of a line, a two-loop bowline on a bight begins by following the same step as a bowline, using a bight of line instead of the working end. Bring the bight through the turn, then feed it around the whole knot, with the bight eventually capturing the two ends of rope exiting the turn.

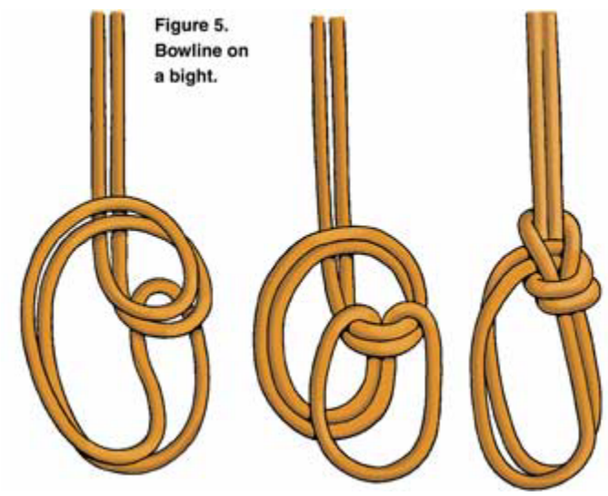


Figure 5. Bowline on a bight.

Clove Hitch

One of the simplest knots used in rigging is the clove hitch (Figure 6). When tied as a midline knot, it is used to send equipment up to the climber. As an endline knot, it is used (when backed up with half hitches) to tie off limbs or sections of wood.

To tie: The clove hitch can be formed around an object by making a turn, crossing the working end over and making another turn in the same direction, and passing the working end under the "bridge." The working end should exit opposite the standing part. The clove hitch is similar in form to the tautline hitch used for climbing. When used for rigging, the working end should be half-hitched to the standing part twice to prevent the hitch from rolling out.

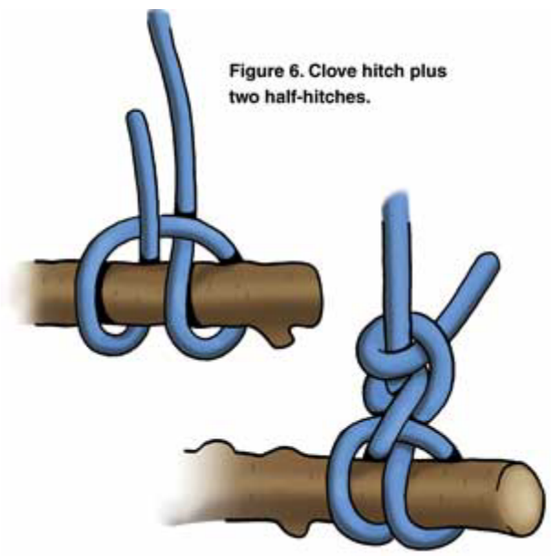


Figure 6. Clove hitch plus two half-hitches.

Marline Hitch and Half Hitch

Climbers often tie either a marline hitch or a half hitch (Figure 7) in addition to the primary rigging knot on a piece being cut. The purpose is to reduce the chances of the primary knot slipping off the piece and to create a more favorable bend ratio in the line before the primary knot.

The primary difference between the half hitch and the marline hitch is that the half hitch collapses if the piece is removed. It also can be a little easier to remove after the piece reaches the ground.

Unlike the half hitch, the marline hitch forms an overhand knot if the piece is removed. For some climbers, it is the preferred choice when security is the main concern.

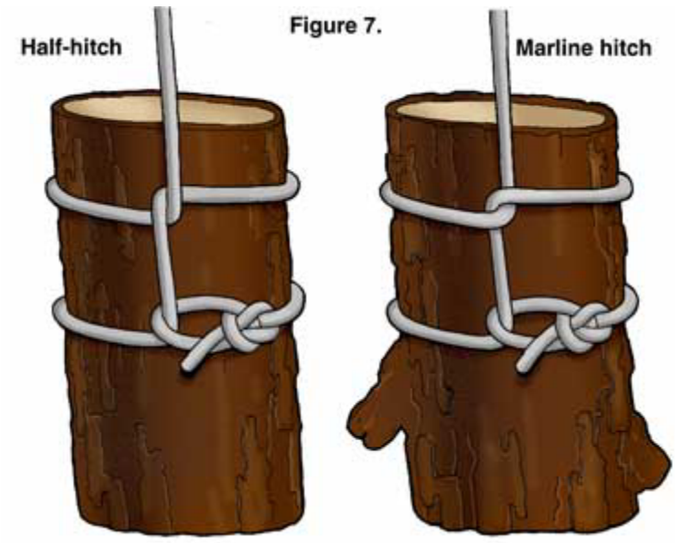


Figure 7.

Slip Knot

An extremely versatile yet simple knot is the slip knot (Figure 8). It is easy to tie, even with one hand. Experienced climbers find many uses for this knot, often as variations of a stopper in the line. The slip knot is a directional knot—it tightens when loaded one way but spills when pulled from the other side.

To tie: A slip knot is tied by taking a counterclockwise turn with the working end to the front, then capturing a bight from the working end in the turn. The knot is asymmetric, and it will slip from the part of the rope used to create the bight (in this instance, the working end). This directional dependence is important in some applications.

Almost any knot can be "slipped." Typically, it means the final tuck of the working end is replaced by tucking a bight instead, so that the knot can be rapidly untied by pulling on the working end. The knot known as the slip knot, though, is a slipped overhand knot. The bow with which we tie our shoes is a doubly slipped square knot. Slipped knots are not appropriate for tying on tools.

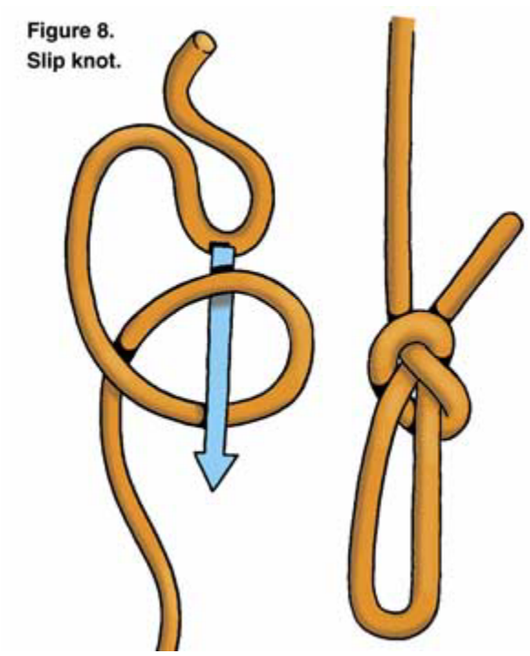


Figure 8.
Slip knot.

Sheet Bend

The sheet bend (Figure 9) is used to join two ropes of different diameter; it often is used to send a line up to the climber. The smaller line should be the one tucked under its own standing part.

To tie: The sheet bend is most easily remembered as a bowline tied with two separate lines. With one line, make a counterclockwise turn over the standing part. Pass the second from back to front through the turn, counterclockwise behind the first, and back down through the turn. When tied correctly, the two ends will exit on the same side of the knot. The sheet bend is one of the more secure bends for lines of different diameter.

Figure 9.
Sheet bend.

Slippery Bend

The slippery bend (Figure 10) is similar to a slipped sheet bend. It's easy to untie and can be instantly spilled by pulling out the bight. It is suitable only for passing (ropes) to the climber.

To tie: Form a bight near the end of one line, then lay the working end of the second line over this bight. Pass the second line behind the first, then over its own standing part. Pass a bight in the second line into the bight from the first line.

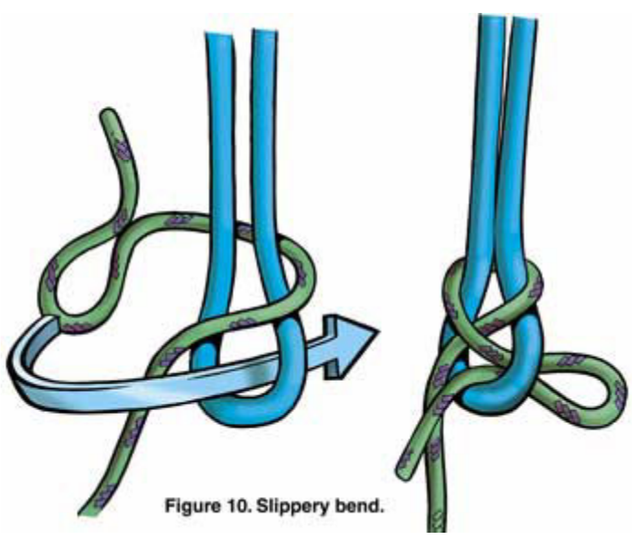


Figure 10. Slippery bend.

Prusik Hitch

The Prusik hitch (Figure 11) is a friction hitch used both in climbing and rigging applications. It is bidirectional in some applications. A smaller-diameter rope is used to attach the Prusik to a working line. The type of rope affects how the knot will work, so it is important to test rope-on-rope combinations before using.

To tie: Hold a fixed loop behind a line and pass the bight from one side through the other side two or three times. It now forms a hitch that will lock securely when pulled in either direction along the line. It also can be tied with a single piece of rope.

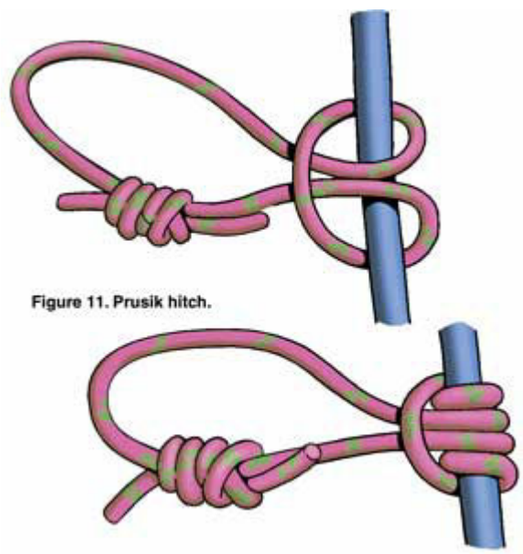


Figure 11. Prusik hitch.

Valdôtain Tresse and *Machard Tresse*

The *Valdôtain tresse (Vt)* and *Machard tresse (Mt)* are variations of the French Prusik. They are friction hitches with application in rigging and climbing. The *Machard tresse* is tied with a fixed loop, while the *Valdôtain tresse* (Figure 12) is tied with a single piece of rope, with knots or splices in either end.

To tie: Either hitch is tied in the same way. The standard form consists of four wraps covered by three braids. Start with the loop or cord on the front of a line and make four counterclockwise wraps down the line. Next, braid the two ends, with the end from the top of the rope crossing over the lower end at the back of the line. The second crossing is at the front with the top end underneath, and the third crossing again at the back with the top end on the outside.

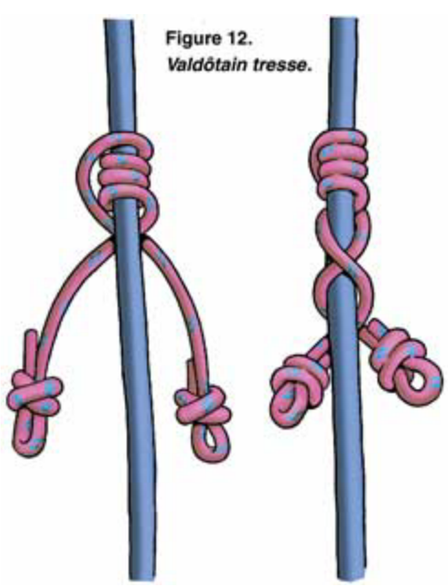


Figure 12.
Valdôtain tresse.

Butterfly

The butterfly (Figure 13) is a good knot for forming a midline loop. It is symmetric, without extreme bends, and usually is easy to untie after use.

To tie (Method 1): A single loop can be formed in the bight with the butterfly. Begin with a bight and impart a 360-degree twist. This move forms two crossings of the legs of the bight. Now fold the bight down to the front, push it down between the legs of the bight, and then up between the two crossings identified earlier.

To tie (Method 2): With your palm facing up, make three turns around your hand. Pick up the turn on the left and place it between the other two. Pick up the turn that is now on the left and place it to the right of the other two, then take this same turn, which is now on the far right, and pass it under and up between the two other turns, passing it from right to left. Pull it through to make a loop, then dress and set the knot.

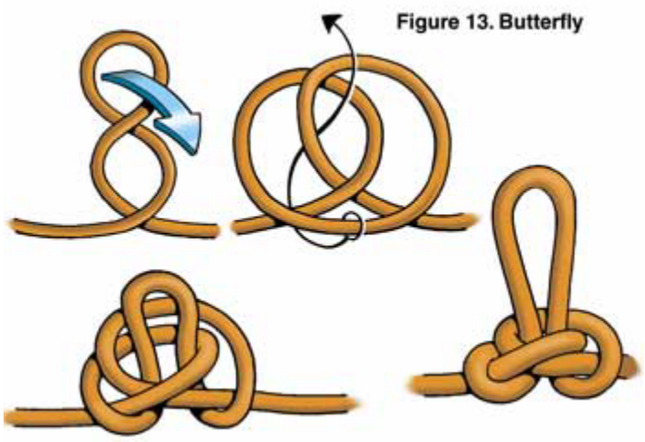


Figure 13. Butterfly

Zeppelin Bend

A zeppelin bend (Figure 14) can be used to attach two lines, and it is a good choice when the lines will be heavily loaded. It is a symmetrical knot that is easy to untie.

To tie: Form a loop in the end of each line, one clockwise and the other counterclockwise, with the ends behind the standing parts. Flip over one of the loops such that the end is in front of the standing part. Place this turn on top of the other with the working ends pointing in opposite directions. Pass the working end from the top down then up inside the two turns. The end from the bottom comes up and down through the turns.

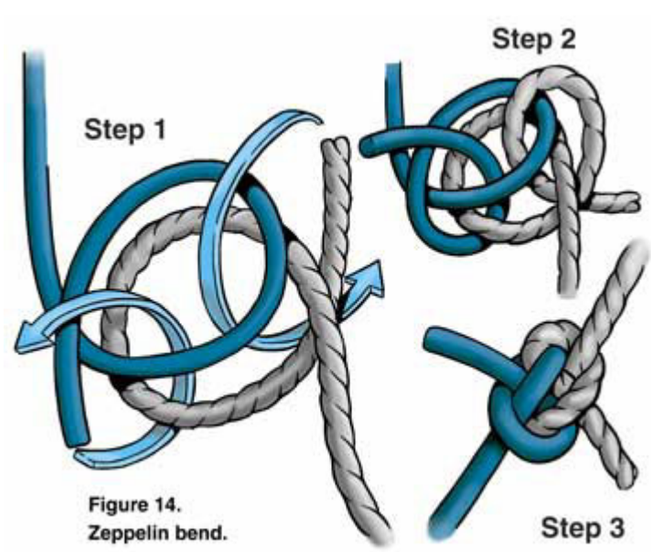


Figure 14.
Zeppelin bend.

Girth Hitch

The girth hitch (Figure 15) is used for attaching loop slings or eye-spliced slings or ropes to an object. It also can be used as a midline knot to attach tools to send to the climber.

To tie: The girth hitch is made by simply taking a wrap around an object with a loop and passing one end of the loop through the other.

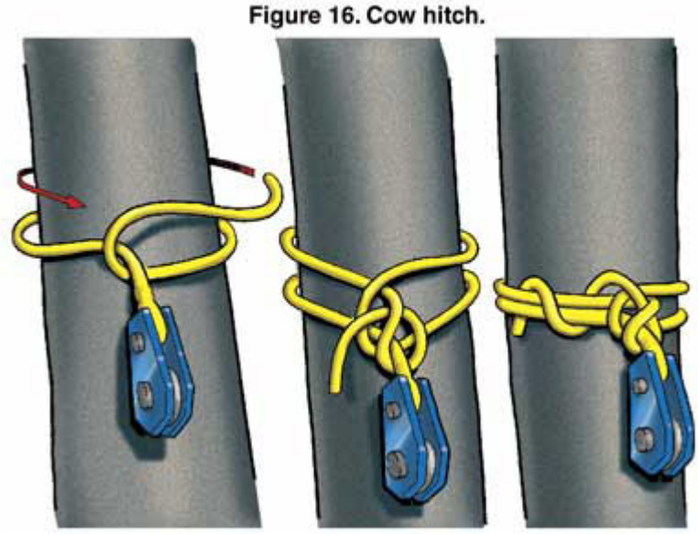
Figure 15.
Girth hitch.

Cow Hitch

The cow hitch (Figure 16) often is used for securing hardware to a tree. It is a variation on the girth hitch but is formed with a line instead of a loop.

To tie: The cow hitch can be reeved by passing the working end around the tree to form a turn, under the standing part, and back around the tree, with the working end exiting in the same direction as the standing part. It resembles a Prusik hitch with fewer turns. When both ends of the cow hitch are loaded, it is called a girth hitch. The cow hitch can roll, so the working end should be half-hitched to the standing part. The direction of this half hitch should be against the bight so that the working end exits back along the direction it entered. The end should be tucked under the turns around the stem to eliminate the potential for the tail to be pulled into running rigging.

Figure 16. Cow hitch.



Timber Hitch

The timber hitch (Figure 17) is used for securing hardware to a tree (especially on large trees when the rope sling is not long enough to tie a cow hitch). This hitch is most secure when tied on larger pieces and when the pull is always against the bight, such that it tightens the hitch on the stem. The sling should never be loaded away from the bight because doing so could loosen it.

To tie: To tie the timber hitch, lead the working end around an object, then turn it around the standing part. Now, moving back around the object in the opposite direction, make a minimum of five tucks with the working end around the line. In 3-strand rope, it is important to make these turns with the lay of the rope; otherwise the rope will flatten out and slip. Spread out these turns and tug the running end to set the knot.

Figure 17. Timber hitch.

Water Knot

Used for joining the ends of webbing to form an endless loop, the water knot (Figure 18) is easy to tie but difficult to untie after loading. It is important to leave long tails to ensure the security of the knot.

To tie: Tie an overhand knot in one end of a length of webbing. Use the other end to retrace the knot, leaving 3- to 4-inch tails.

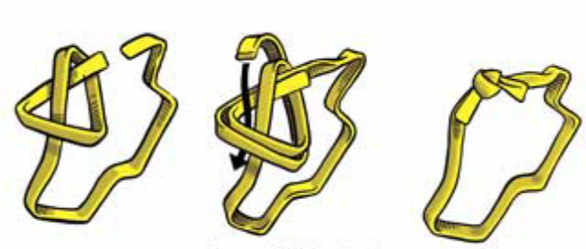


Figure 18. Water knot.

Beer Knot

Interesting for more than its name, the beer knot (Figure 19) is used to join tubular webbing (to form an endless loop). It is considered to be stronger and neater than the water knot.

To tie: Tie an overhand knot in the standing part of a length of tubular webbing. Insert the running end inside the webbing at the working end, and work the overhand knot around until it is over the "splice" or overlapped area, then dress and set. The overlap should be 10 to 12 inches.

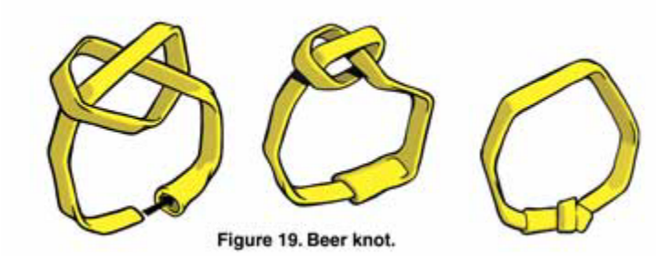


Figure 19. Beer knot.

Arborists use a variety of knots, hitches, and bends in rigging operations. Choosing the best knot for each application can make a big difference in the way the knot performs and the ease of untying after loading. Sometimes one knot might be a much better choice than another in a given situation, and the more familiar you become with these knots, the more you can evaluate them in selecting which knots to use. As always, it is essential that each knot be tied correctly and then dressed and set before using.

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Drawings by Bryan Kotwica.