Chapter 4

FIBER LINE

Starting with this chapter, we explore another major area of steelworking skills-the erection and assembly of steel structure. Steelworkers require tools to hoist and maneuver the steel members into place to erect a structure of any magnitude. These hoisting tools range from uncomplicated devices, such as tripods and gin poles, to more complex mechanisms, such as cranes and motor-powered derricks. Whatever the case, one of the most important components of these hoisting mechanisms is the fiber line or wire rope that must be attached to and hold the load to be hoisted and maneuvered. Before you, as a Steelworker, can become skilled in the supervision of hoisting devices, you must first understand the use and maintenance of fiber line and wire rope.

FIBER LINE

This chapter and the next are designed to familiarize you with the different types of fiber line and wire rope commonly used by Steelworkers. We also discuss knots, bends, hitches, clips, and fittings and describe how they are used. Other topics discussed include the handling and care of fiber line and wire rope, making splices in fiber line, and methods of determining safe working loads.

TYPES OF NATURAL FIBER LINES

Vegetable fibers commonly used in the manufacture of line include manila, sisal, hemp, coir, and cotton.

Manila

Manila is a strong fiber that comes from the leaf stems of the stalk of the abaca plant, which belongs to the banana family. The fibers vary in length from 4 to 12 feet in the natural state. The quality of the fiber and its length give manila line relatively high elasticity, strength, and resistance to wear and deterioration. A good grade of manila is cream in color, smooth, clean, and pliable. Poorer grades of manila are characterized by varying shades of brown. In many instances, the manufacturer treats the line with chemicals to make it more mildew resistant, which increases the quality of the line. Manila line is generally the standard item of issue because of its quality and relative strength.

Sisal

The next best line-making fiber is sisal. It is made from two tropical plants—sisalana and henequen. The fiber is similar to manila, but lighter in color. It is grown in the East Indies, Africa, and Central America. Sisal fibers are usually 26 to 40 inches (65 cm to 1 m) long but are only about 80 percent as strong as manila fibers. Sisal line withstands exposure to seawater exceptionally well. It is frequently used in towing, mooring, and similar purposes.

Hemp

Hemp is a tall plant that provides useful fibers for making line and cloth. It is cultivated in the United States, Russia, Italy, and South America. Hemp was used extensively before the introduction of manila. Throughout the Navy the principal use is for small stuff, ratline, marline, and spun yarn. Since hemp absorbs tar much better than the hard fibers, these fittings are invariably tarred to male them water resistant. The term *small stuff* is used to describe small cordage that a layman may call string, yarn, or cords. Tarred hemp has about 80 percent of the strength of untarred hemp. Of these tarred fittings, marline is the standard item of issue.

Coir

Coir line is a light line made from the fiber of coconut husks and is light enough to float on water. A resilient rough line, it has about one fourth of the strength of hemp; therefore, the use of coir is restricted to small lines.

Cotton

Cotton line is a smooth white line that stands much bending and running. Cotton is not widely used in the Navy except, in some cases, for small lines.

TYPES OF SYNTHETIC FIBER LINES

Although natural fiber line is normally used, a number of synthetic fibers are also used to make line. The synthetic fibers used to fabricate line include the following: nylon, Kevlar, Orion, and Dacron.

Of the types of line made from synthetic fibers, nylon is the one used the most. The primary benefit of using nylon line is that the breaking (tensile) strength of nylon line is nearly three times that of manila line. An additional benefit of using nylon line is that it is waterproof and has the ability to resume normal length after being stretched and absorbing shock. It also resists abrasion, rot, decay, and fungus growth.

FABRICATION OF LINE

The fabrication of line consists essentially of three twisting operations. First, the FIBERS are twisted to the right to form the YARNS. Second, the yarns are twisted to the left to form the STRANDS. Third, the strands are twisted to the right to form the LINE. Figure 4-1 shows you how the fibers are grouped to form a three-strand line.

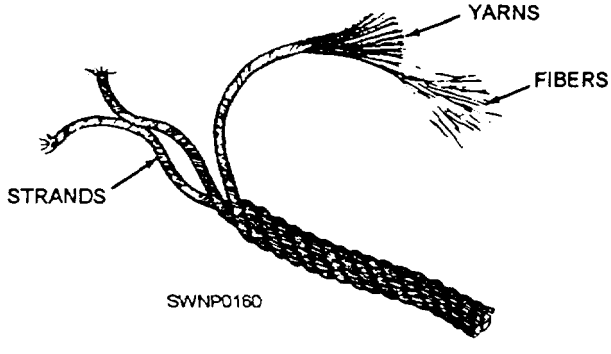


Figure 4-1.—Fabrication of line.

The operations just described are standard procedure. The product produced is known as a RIGHT-LAID line. The process is sometimes reversed, then you have what is known as a LEFT-LAID line. In either instance, the principle of opposite twists must always be observed. One reason for this is to keep the line tight or stable and prevent the elements from unlaying when a load is suspended on it. Another reason for twisting the elements of a line in opposite directions is to prevent moisture penetration.

TYPES OF LAYS OF LINE

There are three types of lays of fiber line with which you should be familiar. They are the HAWSER-LAID, SHROUD-LAID, and CABLE-LAID lines. Each type is shown in figure 4-2.

Hawser-Laid Line

Hawser-laid line generally consists of three strands twisted together, usually in a right-hand direction.

Shroud-Laid Line

Ordinarily, a shroud-hid line is composed of four strands twisted together in a right-hand direction around a center strand or core. This core is usually of the same material but smaller in diameter than the four strands. You will find that shroud-laid line is more pliable and stronger than hawser-laid line. You will also find that shroud-laid line has a strong tendency to kink. In most instances, it is used on sheaves and drums. This not only prevents kinking but also makes use of its pliability and strength.

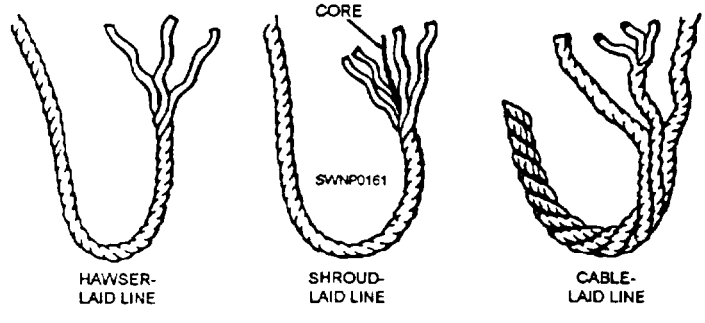


Figure 4-2.—Lays of line.

Cable-Laid Line

Cable-laid line usually consists of three right-hand hawser-laid lines twisted together in a left-hand direction. This type is especially useful in heavy construction work, because if it tends to untwist, it will tighten any regular right-hand screw connection to which it may be attached; hence, its use provides an added safety feature.

SIZE DESIGNATION OF LINE

The size of a line larger than 1 3/4 inches (44.5 mm) in circumference is generally designated by its circumference in inches. A 6-inch (15-cm) manila line, for instance, would be constructed of manila fibers and measure 6 inches (15 cm) in circumference. Line is available up to 16 inches (40 cm) in circumference, but 12 inches (30 cm) is normally the largest line carried in stock. Anything larger is used only on special jobs (fig. 4-3).

Line 1 3/4 inches (44.5 mm) or less in circumference is called SMALL STUFF, and size is usually designated b y the number of threads (or yarns) that make up each strand. You may find 6- to 24-thread small stuff, but the most common sizes are 9- to 21-thread (fig. 4-3). You may hear some small stuff designated by name without reference to size. One such type is MARLINE-a tarred, two-strand, left-laid hemp. Marline is the small stuff you used the most for seizing. When you need something stronger than marline, use a tarred, three-strand, left-laid hemp, called HOUSELINE.

MANILA LINE

SOME COMMONLY USED SIZES	*CIRCUMFERENCE		NOMINAL DIAMETER
	INCHES	MILLIMETERS	
	3/4	19.05	1/4
	1	25.40	5/16
	1-1/8	28.58	3/8
	1-1/4	31.76	7/16
	1-1/2	38.10	1/2
	1-3/4	44.45	9/16
	2	50.80	5/8
	3	76.20	1
	4	101.6	1-1/4
	5	127.0	1-8/16
	6	152.4	2

* SIZE IS DESIGNATED BY THE CIRCUMFERENCE

SWNP0162

Figure 4-3.—Size designation of line.

If you ever order line, you may find that you have to order it by diameter. The catalog may also use the term rope (rather than line).

ROPE YARNS for temporary seizings, whippings, and lashings are pulled from large strands of old line that has outlived its usefulness. Pull your yarn from the middle, away from the ends, or it will get fouled.

HANDLING AND CARE OF FIBER LINE

If you expect the fiber line you work with to give safe and dependable service, make sure it is handled and cared for properly. Procedures for the handling and care of fiber line are as follows:

• CLEANLINESS is part of the care of fiber line. NEVER drag a line over the ground nor over rough or dirty surfaces. The line can easily pick up sand and grit that can work into the strands and wear the fibers. If a line does get dirty, use water only to clean it. Do NOT use soap because it takes oil out of the line.

• AVOID pulling a line over sharp edges because the strands may break. When you have a sharp edge, place chafing gear, such as a board, folded cardboard or canvas, or part of a rubber tire, between the line and the sharp edge to prevent damaging the line.

• NEVER cut a line unless you have to. When possible, always use knots that can be untied easily.

Fiber line contracts, or shrinks, if it gets wet. If there is not enough slack in a wet line to permit shrinkage, the line is likely to overstrain and weaken. If a taut line is exposed to rain or dampness, make sure that the line, while still dry, is slackened to allow for the shrinkage.

When nylon line is properly handled and maintained, it should last more than five times longer than manila line subjected to the same use. Nylon line is also lighter, more flexible, less bulky, and easier to handle and store than manila line. When nylon line is wet or frozen, it loses little strength. Additional y, nylon line is resistant to mildew, rotting, and attack by marine borers.

If a nylon line becomes slippery because of grease, it should be cleaned with light oils, such as kerosene or diesel oil.

Uncoiling Line

New line is coiled, bound, and wrapped in burlap. This protective covering should not be removed until the line is to be used because it protects the line during storage and prevents tangling. To open, remove the burlap wrapping and look inside the coil for the end of the line. This should be at the bottom of the coil. If it is not, turn the coil over so that the end will be at the bottom. Pull the end of the line up through the center of the coil (fig. 4-4). As the line comes up through the coil, it will unwind in a counterclockwise direction.

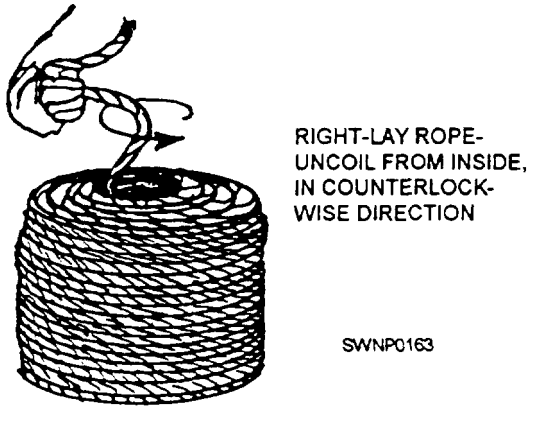
Uncoiling Nylon Line

Do not uncoil new nylon line by pulling the ends up through the eye of the coil. Avoid coiling nylon in the same direction all the time, or you could unbalance the lay.

Making Up Line

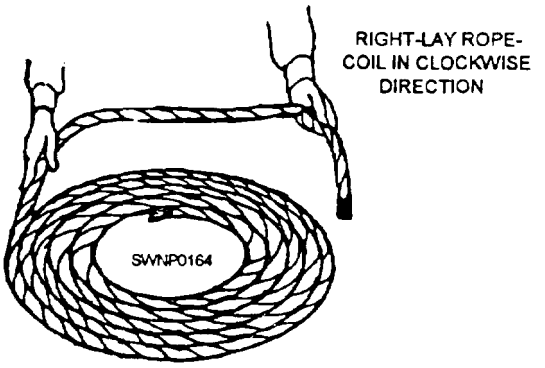
After the line has been removed from the manufacturer's coil, it may be MADE UP (that is, prepared for storage or for use) by winding on a reel. It may also be made up by cooling down, faking down, or blemishing down.

To COIL DOWN a line simply means to lay it in circles, roughly one on top of the other (fig. 4-5). Line should always be coiled in the same direction as the lay-clockwise for right lay and counterclockwise for left lay. When a line has been coiled down, one end is ready to run off. This is the end that went down last and is now on top. If, for some reason, the bottom end must go out first, you will have to turn your coil over to free it for running.



UNCOILING A NEW COIL OF FIBER ROPE

Figure 4-4.—Uncoiling line.



COILING OF A FIBER ROPE AFTER BEING USED

Figure 4-5.—Colling down line after use

Whipping a Line

The term whipping refers to the process of securing the ends of a line to prevent the strands from unlaying and the yams from separating or fraying. It will not increase the size of the line enough to prevent the fitting of the blocks or openings through which it must pass. Whippings are made with fine twine.

Figure 4-6 shows the steps to follow in applying a whipping. Make a loop in the end of the twine and place the loop at the end of the line, as shown in the figure. Wind the standing part around the line covering the loop of the whipping. Leave a small loop uncovered, as shown. Pass the remainder of the standing end up through the small loop and pull the dead end of the twine, thus pulling the small loop and the standing end back towards the end of the line underneath the whipping. Pull the dead end of the twine until the loop with the standing end through it reaches a point midway underneath the whipping. Trim both ends of the twine closeup against the loops of the whipping.

Before cutting a line, place two whippings on the line 1 or 2 inches apart and make the cut between the whippings, as shown in figure 4-7. This procedure prevents the ends from untwisting after they are cut.

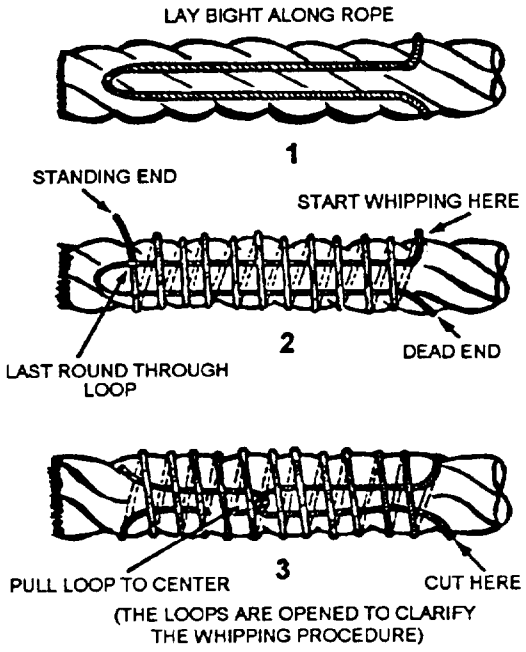


Figure 4-6.—Whipping a line.

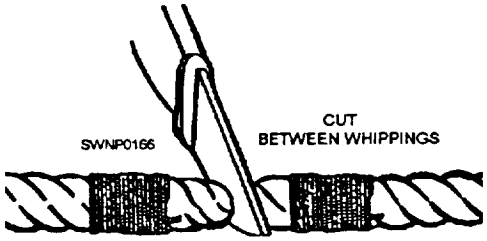


Figure 4-7.—Cutting a line between whipping.

Inspecting Line

The exterior appearance of fiber line is not always a good indication of its internal condition. Line softens with use, and dampness, heavy loads, fraying, breaking or broken strands, and dragging over rough surfaces all contribute to line weakening and failure. Also, overloading a line can cause it to part and heavy damage to material, equipment, and serious injury to personnel can result. For these reasons, line should be inspected carefully at regular intervals to determine whether it is safe for use.

The interior of a line can be checked by untwisting the strands slightly. Line that is mildewed gives off a musty odor. Broken strands or yams usually can be spotted immediately by a trained observer. You will want to look carefully to ensure there is no dirt or sawdust-like material inside the line. The presence of dirt or other foreign matter indicates possible damage to the internal structure of the line. In line having a central core, the core should not break away in small pieces upon examination. If this occurs, it indicates that the line has been overloaded. Additionally, a decrease in line circumference is usually a sure sign that an excessive strain has been applied to the line.

For a thorough inspection, a line should be examined at several places. After all, only one weak spot—anywhere in the line-makes the entire line weak. As a final check if the line appears to be satisfactory in all aspects, pull out a couple of fibers from the line and try to break them. Sound fibers show a strong resistance to breakage.

If an inspection discloses any unsatisfactory conditions in a line, destroy it or cut it into small pieces as soon as possible. This precaution will prevent the possibility of the defective line being used for hoisting purposes, but save the small pieces for miscellaneous uses on the jobsite.

As with manila, nylon line is measured by circumference. Nylon, as manila, usually comes on a reel of 600 to 1,200 feet, depending upon the size.

Storing Line

When fiber line is to be stored, certain precautions must be taken to safeguard the line against deterioration. A line should never be stored when wet. Always dry the line well before placing it in storage.

After being used, a line should be coiled down in a clockwise direction (assuming it is a right-hand lay). Should the line be kinked from excessive turns, remove them by the procedure known as “thorough footing.” This is accomplished by coiling the line down counterclockwise and then pulling the bottom end of the coil up and out the middle of the coil. If the line is free of kinks as it leaves the coil, make it up in the correct manner. If the line is still kinked, repeat the process before making up the line for storage.

Where you store line deserves careful consideration. Line deteriorates rapidly if exposed to prolonged dampness; therefore, it is important that the storage area is dry, unheated, and well-ventilated. To permit proper air circulation, place the line in loose coils on a wood grating platform about 6 inches (15 cm) above the floor. You can also hang the line in loose coils on a wooden peg. Avoid continuous exposure of line to sunlight because excessive sunlight can damage the

line. Do not store nylon line in strong sunlight. Cover it with tarpaulins.

As a final precaution, line should NEVER be exposed to lime, acids, or other chemicals, or even stored in a room containing chemicals. Even the fumes may severely damage the line.

STRENGTH OF FIBER LINE

Overloading a line poses a serious safety threat to personnel It is also likely to result in heavy losses through damage to material and equipment. To avoid overloading, you must know the strength of the line with which you are working. This involves three factors: breaking strength, safe working load, and safety factor.

Breaking Strength

The term *breaking strengfh* refers to the tension at which the line will break apart when an additional load is applied. The breaking strength of the various lines has been determined through tests made by line manufacturers, and tables have been established to provide this information. In the absence of a manufacturer's table, a rule of thumb for finding the breaking strength of manila line is as follows:

C squared x 900 = BS

In this rule, C = circumference in inches and BS = breaking strength in pounds. The circumference is squared and the figure obtained is then multiplied by 900 to find BS. With a 3-inch line, for example, you will get a BS of 8,100 pounds. This was figured as follows:

3 x 3 x 900 = 8,100 lb

When the line is measured in centimeters, the breaking strength can be figured in kilograms. The same equation is used with only the constant being changed to 64.8 (vice 900). The breaking strength in kilograms is figured as follows:

7.5 cm x 7.5 cm x 64.8 = 3,645 kg

The breaking strength of manila line is higher than that of an equal-size sisal line. This is because of the difference in strength of the two fibers. The fiber from which a particular line is constructed has a definite bearing on its breaking strength.

Safe Working Load

Briefly defined, the safe working load of a line is the load that can be applied without causing damage to the line. Remember that the safe working load of a line is considerably less than the breaking strength. A wide margin of difference between breaking strength and safe working load is necessary to allow for such factors as additional strain imposed on the line by jerky movements in hoisting or bending over sheaves in a pulley block

You may not always have a chart available to tell you the safe working load for a particular size line. Fortunately, there is a rule of thumb with which you can determine the safe working load (SWL).

SWL = C squared x 150

SWL = the safe working load in pounds

C = the circumference of the line in inches

To determine the SWL, simply take the circumference of the line, square it, and then multiply by 150. For example, for a 3-inch line, here is how the rule works:

3 x 3 x 150= 1,350 lb

Thus the safe working load of a 3-inch line is 1,350 pounds.

In the metric system, the rule is as follows:

SWL = C squared x 10.8

SWL = the safe working load in kilograms

C = the circumference of the line in centimeters

Substituting in the equation for a 3-inch line the centimeter equivalent of 3 inches (3 inches = 7.5 cm), the formula becomes the following:

7.5 cm x 7.5 cm x 10.8 = 607.5 kg

Thus the safe working load of a line 7.5 cm in circumference is equal to 607.5 kg.

NOTE: 10.8 is the metric constant equivalent to 150 in the decimal system.

If the line is in good shape, add 30 percent to the calculated SWL. If it is in bad shape, subtract 30 percent from the SWL. In the example given above for the 3-inch line, adding 30 percent to the 1,350 pounds would give you a safe working load of 1,755 pounds. On the other hand, subtracting 30 percent from the 1,350 pounds would leave you a safe working load of 945 pounds.

Remember that the strength of a line will decrease with age, use, and exposure to excessive heat, boiling water, or sharp bends. Especially with used line, these and other factors affecting strength should be given careful consideration and proper adjustment made in the breaking strength and safe working load capacity of the line. Manufacturers of line provide tables to show the breaking strength and safe working load capacity of line. You will find such tables useful in your work; however, you must remember that the values given in manufacturers' tables apply to NEW LINE used under favorable conditions. For that reason, you must PROGRESSIVELY REDUCE the values given in the manufacturers' tables as the line ages or deteriorates with use.

The safety factor of a line is the ratio between the breaking strength and the safe working load. Usually a safety factor of 4 is acceptable, but this is not always the case. In other words, the safety factor will vary, depending on such things as the condition of the line and circumstances under which it is to be used. While the safety factor should never be less than 3, it often must be well above 4 (possibly as high as 8 or 10). For best, average, or unfavorable conditions, the safety factors indicated below are usually suitable.

Best condition (new line): 4.

Average condition (line used, but in good condition): 6.

Unfavorable condition (frequently used line, such as running rigging): 8.

Breaking Strength of Nylon Line

The breaking strength of nylon line is almost three times that of manila line of the same size. The rule of thumb for the breaking strength of nylon line is as follows:

BS = C squared x 2,400

NOTE: The symbols in this rule are the same as those for fiber line in both the English and metric systems.

Application of the formula: determine the BS for a 2 1/2-inch nylon line in both pounds and kilograms:

Solution: BS = 2.5 x 2.5 x 2,400 = 15,000 pounds or BS = 6.35 cm x 6.35 cm x 172.8 = 6,967 kilograms

NOTE: The constant for the metric system is 172.8.

Nylon line can withstand repeated stretching to this point with no serious effects. When nylon line is underload, it thins out. Under normal safe working loads, nylon line will stretch about one third of its length. When free of tension, it returns to its normal size.

When nylon line is stretched more than 40 percent, it is likely to part. The stretch is immediately recovered with a snapback that sounds like a pistol shot .

WARNING

The snapback of a nylon line can be as deadly as a bullet. This feature is also true for other types of lines, but overconfidence in the strength of nylon may lead one to underestimate its backlash; therefore, ensure that no one stands in the direct line of pull when a heavy strain is applied to a line.

The critical point of loading is 40-percent extension of length; for example, a 10-foot length of nylon line would stretch to 14 feet when underload. Should the stretch exceed 40 percent, the line will be in danger of parting.

Nylon line will hold a load even though a considerable number of strands are abraded. Ordinarily, when abrasion is localized the line maybe made satisfactory for reuse by cutting away the chafed section and splicing the ends.

KNOTS, BENDS, AND HITCHES

The term *knot* is usually applied to any tie or fastening formed with a cord, rope, or line. In a general sense, it includes the words *bends* and *hitches.*

Line Parts

A BEND is used to fasten two lines together or to fasten a line to a ring or loop. A HITCH is used to fasten a line around a timber or spar, so it will hold temporarily but can be readily untied. Many ties, which are strictly bends, have come to be known as knots; hence, we will refer to them as knots in this discussion.

Knots, bends, and hitches are made from three fundamental elements: a bight, a loop, and a round turn. Observe figure 4-8 closely and you should experience no difficulty in making these three elements. Note that the free or working end of a line is known as the RUNNING END. The remainder of the line is called the STANDING PART.

NOTE: A good knot is one that is tied rapidly, holds fast when pulled tight, and is untied easily. In addition to the knots, bends, and hitches described in the following paragraphs, you may have need of others in steelworking. When you understand how to make those covered in this chapter, you should find it fairly easy to learn the procedure for other types.

Overhand Knot

The OVERHAND KNOT is considered the simplest of all knots to make. To tie this knot, pass the hose end of a line over the standing part and through the loop that has been formed. Figure 4-9 shows you what it looks like. The overhand knot is often used as a part of another knot. At times, it may also be used to keep the end of a line from untwisting or to form a knob at the end of a line.

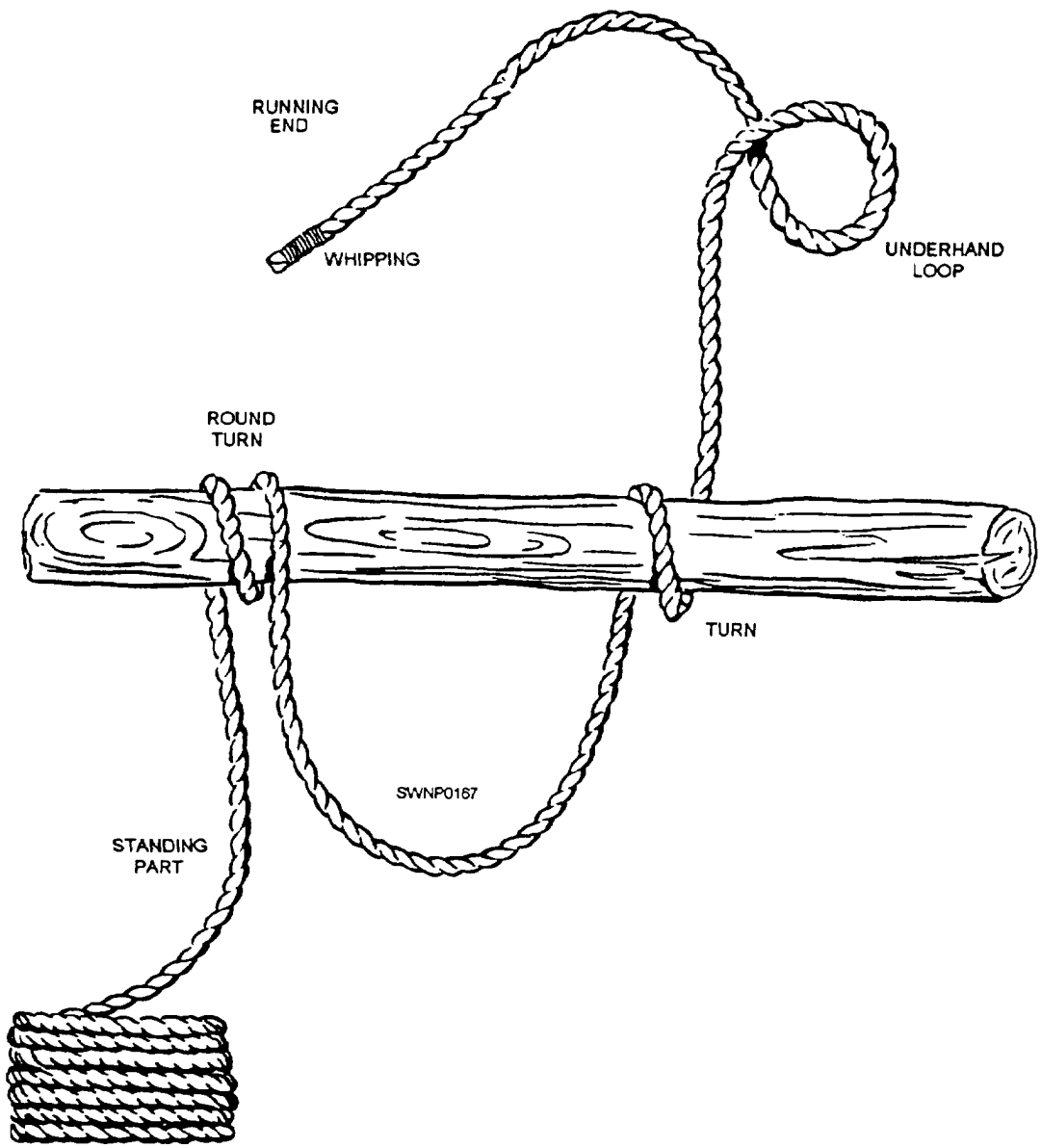


Figure 4-8.—Elements of knots, bends, and hitches

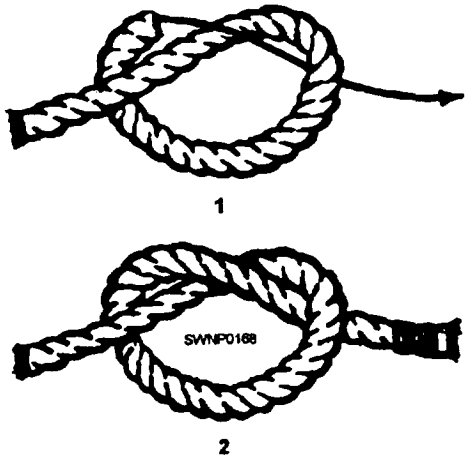


Figure 4-9.—Overhand knot.

Figure-Eight Knot

The FIGURE-EIGHT KNOT is used to form a larger knot than would be formed by an overhand knot in the end of a line (fig. 4-10). A figure-eight knot is used in the end of a line to prevent the end from slipping through a fastening or loop in another line. To make the figure-eight knot, make a loop in the standing part, pass the running end around the standing part, back over one side of the loop and down through the loop, and pull tight.

Square Knot

The SQUARE KNOT, also called the REEF KNOT, is an ideal selection for tying two lines of the same size together so they will not slip. To tie a square knot, first bring the two ends of the line together and make an overhand knot. Then form another overhand knot in the opposite direction, as shown in figure 4-11.

NOTE: A good rule to follow for a square knot is left over right and right over left.

When tying a square knot, make sure the two overhand knots are parallel. 'his means that each running end must come out parallel to the standing part of its own line. If your knot fails to meet this test, you have tied what is known as a "granny." A granny knot should NEVER be used; it is unsafe because it will slip under strain. A true square knot instead of slipping under strain will only draw tighter.

Sheepshank

The SHEEPSHANK is generally thought of as merely a means to shorten a line, but, in an emergency, it can also be used to take the load off a weak spot in the line. To make a sheepshank, form two bights

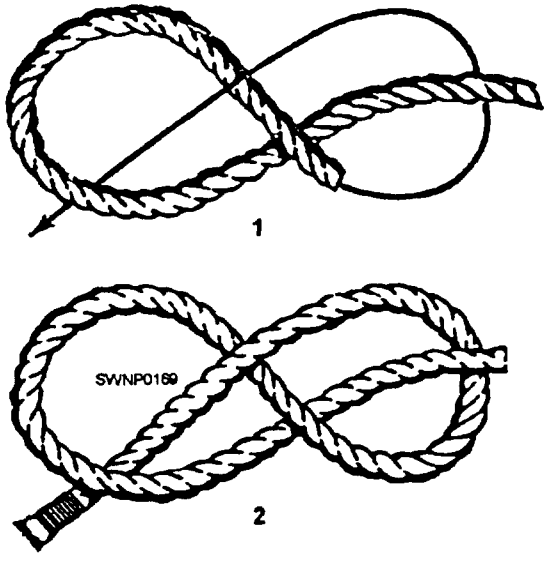


Figure 4-10.—Figure-eight knot

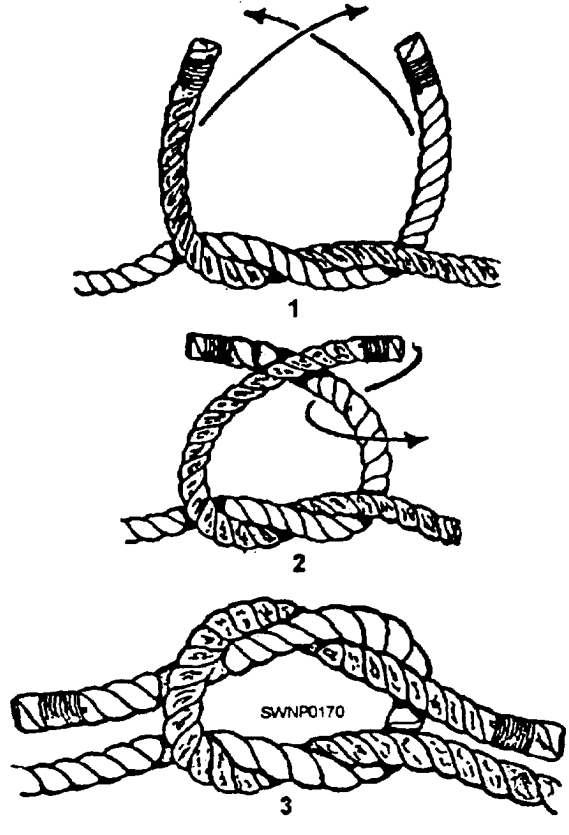


Figure 4-11.—Square knot.

(fig. 4-12, view 1). Then take a half hitch around each bight (views 2 and 3). In case you are using the sheepshank to take the load off a weak spot, make sure the spot is in the part of the line indicated by the arrow in view 2.

Bowline

The BOWLINE is especially useful when you need a temporary eye in the end of a line. It will neither slip nor jam and can be untied easily. To tie a bowline, follow the procedure shown in figure 4-13.

The FRENCH BOWLINE is sometimes used to lift or hoist injured personnel. When the french bowline is used for this purpose, it has two loops which are adjustable, so even an unconscious person can be lifted safely. One loop serves as a se at for the person, while the other loop goes around the body under the person's arms. The weight of the person keeps both loops tight and prevents the person from falling. The procedure to follow in making the french bowline is shown in figure 4-14.

Spanish Bowline

The SPANISH BOWLINE is useful in rescue work, especially as a substitute for the boatswain's chair. It may also be used to give a twofold grip for lifting a pipe or other round object in a sling. Many people prefer the spanish bowline to the french bowline because the bights are set and will not slip

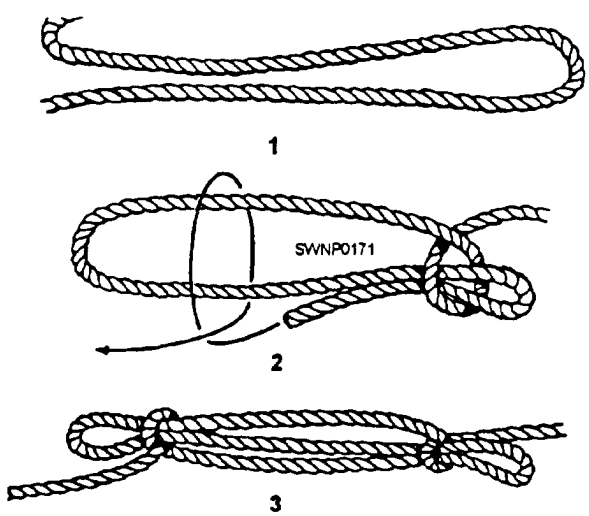


Figure 4-12.—Sheepshank.

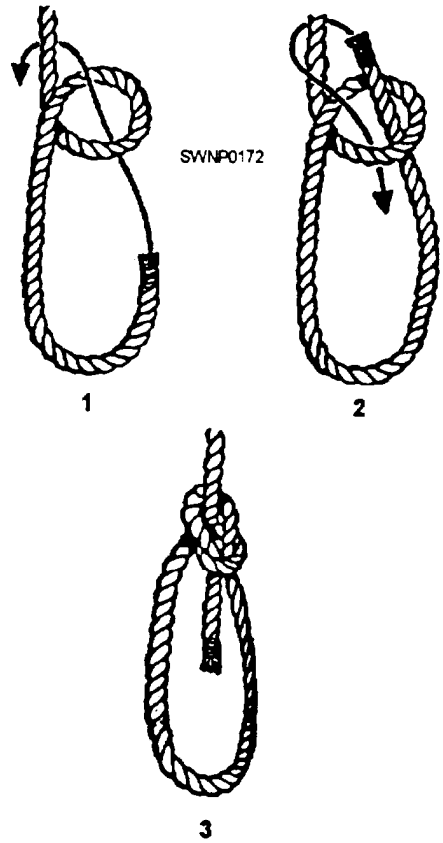


Figure 4-13.—Bowline.

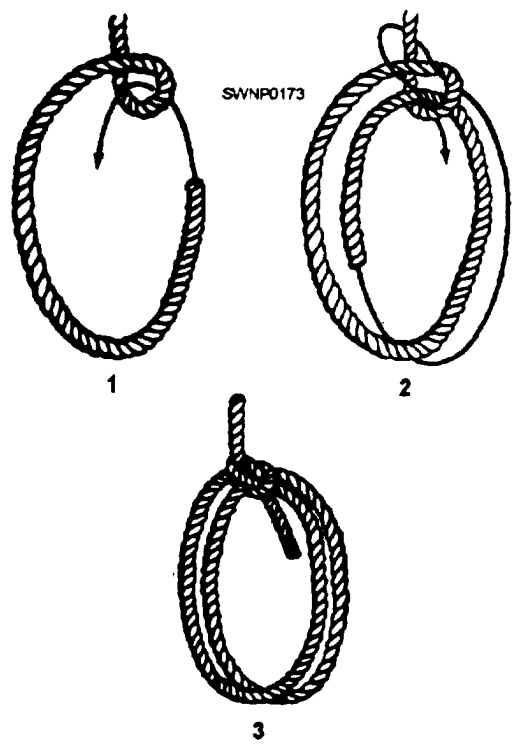


Figure 4-14.—French bowline.

back and forth (as in the french bowline) when the weight is shifted.

To tie a spanish bowline, take a bight and bend it back away from you (fig. 4-15, view 1), forming two bights. Then lap one bight over the other (view 2). Next, grasp the two bights where they cross at (a) in view 2. Fold this part down toward you, forming four bights (view 3). Next, pass bight (c) through bight (e) and bight (d) through bight (f) (view 4). The complete knot is shown in view 5.

Running Bowline

The RUNNING BOWLINE is a good knot to use in situations that call for a lasso. To form this knot, start by making a bight with an overhand loop in the running end (fig. 4-16, view 1). Now, pass the running end of the line under and around the standing part and then under one side of the loop (view 2). Next, pass the running end through the loop, under and over the side of the bight, and back through the loop (view 3).

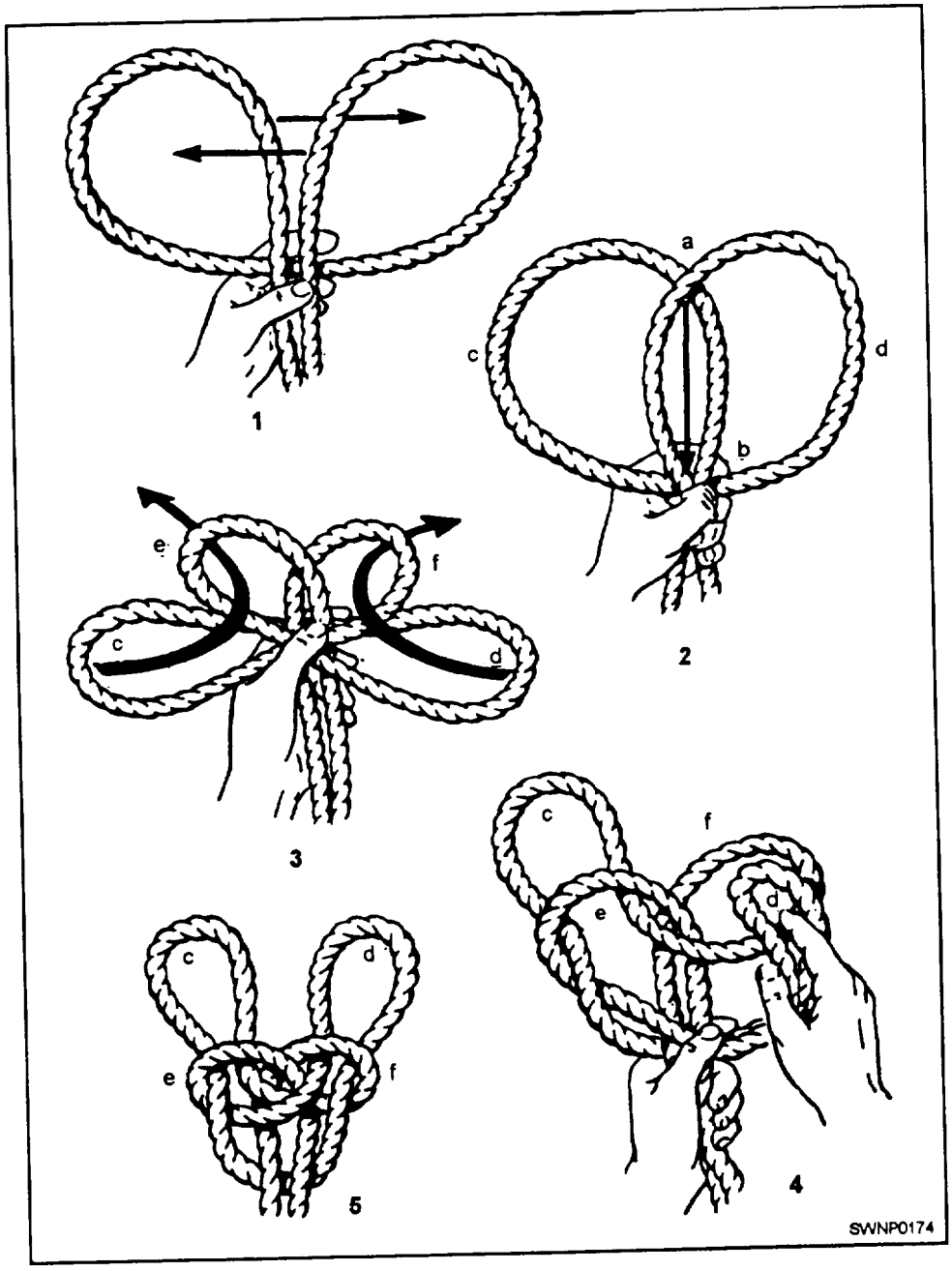


Figure 4-15.—Spanish bowline

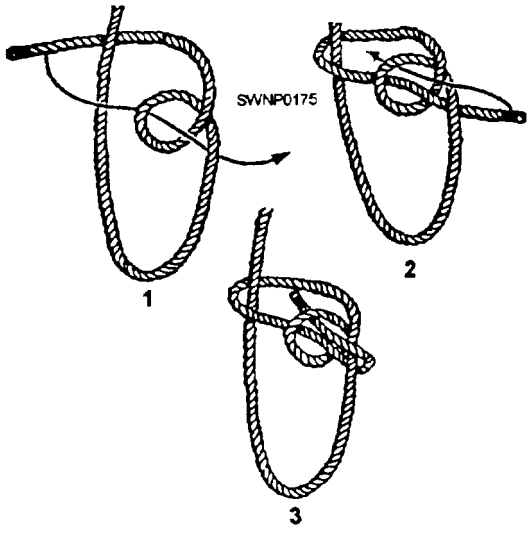


Figure 4-16.—Running bowline.

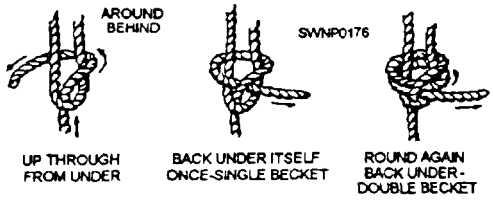


Figure 4-17.—Becket bend.

Becket Bend

An especially good knot for bending together two lines that are unequal in size is the type known as the BECKET BEND. The simple procedure and necessary instructions for tying a becket, single and double, are given in figure 4-17.

Clove Hitch

When it comes to bending to a timber or spar or anything that is round or nearly round, the familiar CLOVE HITCH is an ideal selection. Figure 4-18 shows how this knot is made. A clove hitch will not jam or pull out; however, if a clove hitch is slack, it might work itself out, and for that reason, it is a good idea to make a HALF HITCH in the end, as shown in figure 4-19, view 1. A half hitch never becomes a whole hitch. Add a second one and all you have is two half hitches, as shown in figure 4-19, view 2.

The SCAFFOLD HITCH is used to support the end of a scaffold plank with a single line. To make the scaffold hitch, lay the running end across the top and around the plank, then up and over the standing

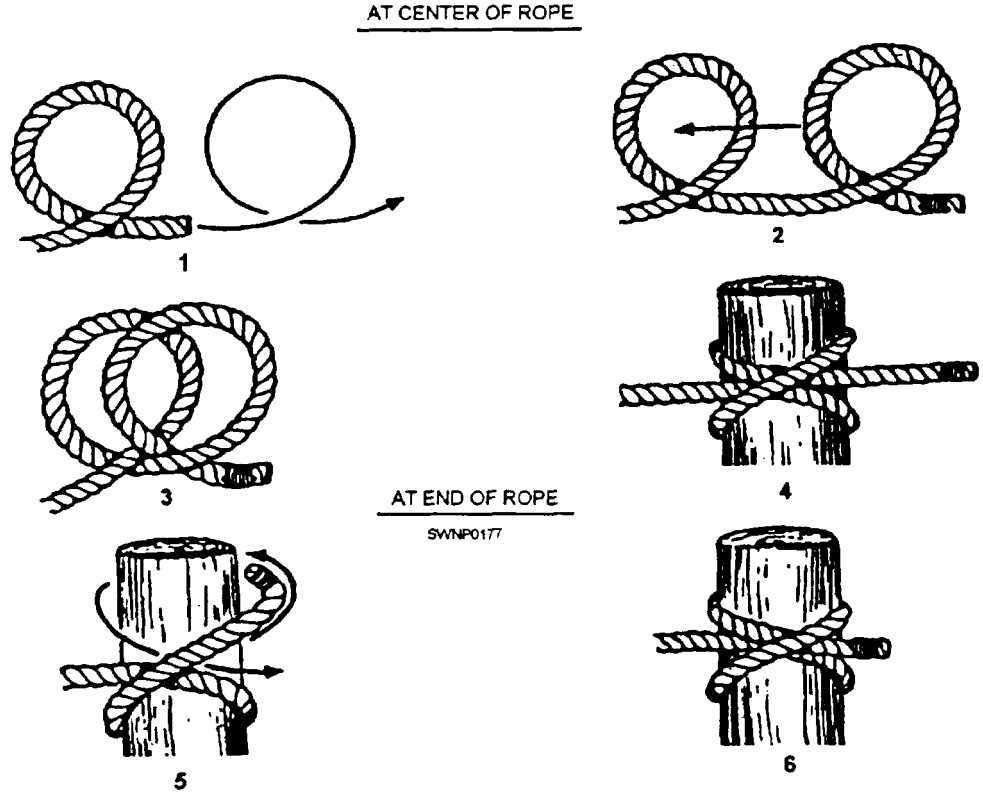


Figure 4-18.—Clove hitch.

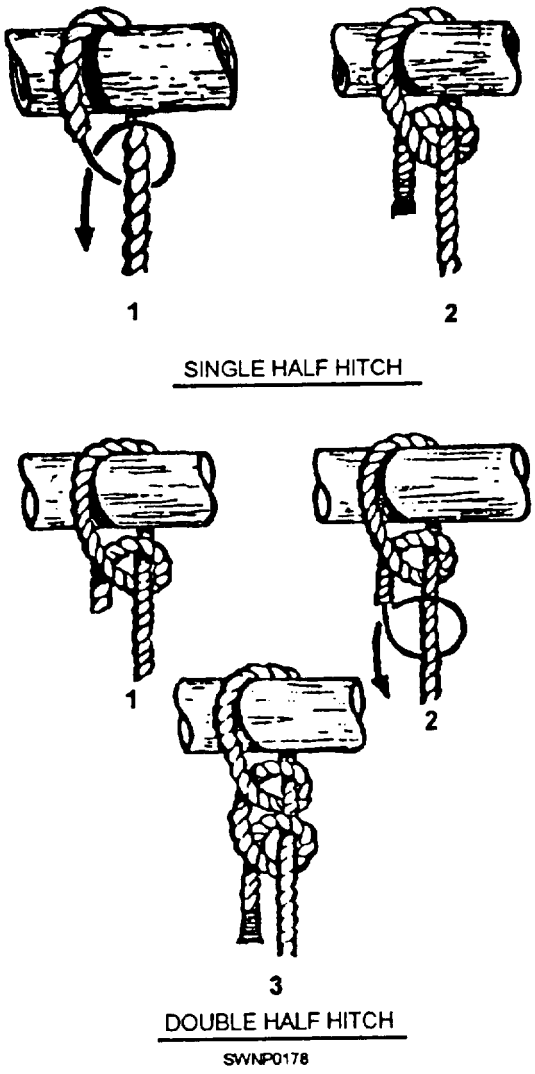


Figure 4-19.—Half hitch.

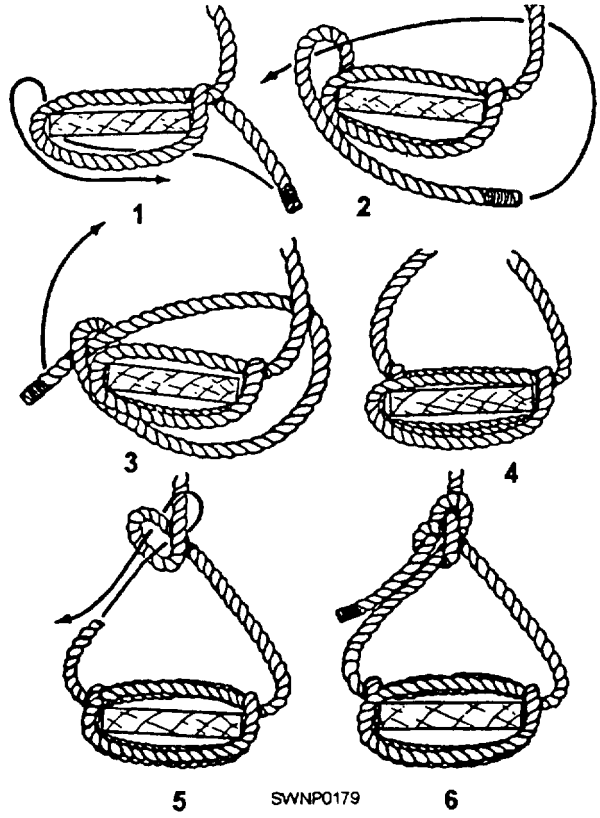


Figure 4-20.—Scaffold hitch.

part (fig. 4-20, view 1). Bring a doubled portion of the running end back under the plank (view 2) to form a bight at the opposite side of the plank. The running end is taken back across the top of the plank (view 3) until it can be passed through the bight. Make a loop in the standing part (view 4) above the plank. Pass the running end through the loop and around the standing part and back through the loop (view 5).

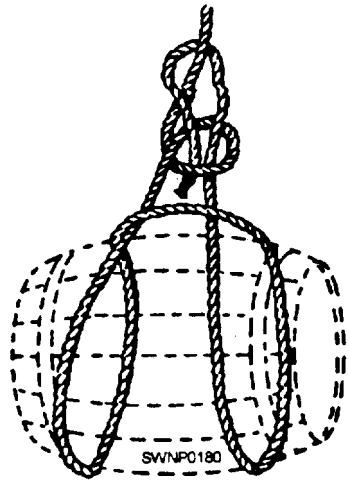


Figure 4-21.—Barrel hitch.

Barrel Hitch

A BARREL HITCH can be used to lift a barrel or other rounded object that is either in a horizontal or a vertical position. To sling a barrel horizontally (fig. 4-21), start by making a bowline with a long bight. Then bring the line at the bottom of the bight up over the sides of the bight. To complete the hitch, place the two "ears" thus formed over the end of the barrel.

To sling a barrel vertically, pass the line under the bottom of the barrel, bring it up to the top, and then form an overhand knot (fig. 4-22, view 1). While maintaining a slight tension on the line, grasp the two

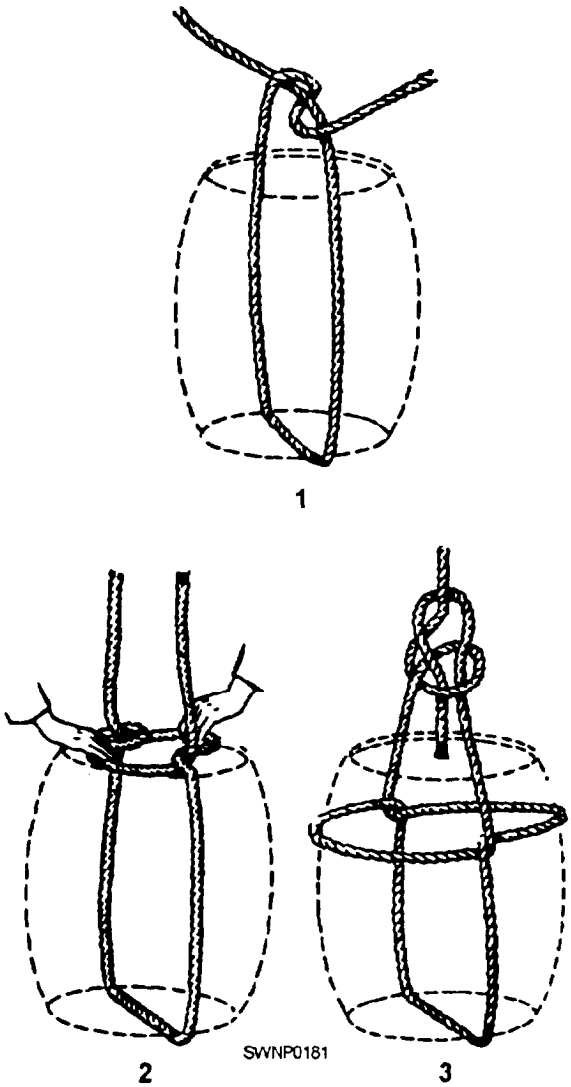


Figure 4-22.—A vertical barrel hitch.

parts of the overhand knot (fig. 4-22, view 2) and pull them down over the sides of the barrel. Finally, pull the line snug and make a bowline over the top of the barrel (fig. 4-22, view 3).

SPLICING FIBER LINE

When it is necessary to join lengths of line, a splice, rather than a knot, should be used. A properly made short splice will retain up to 100 percent of the strength of the line, while a knot will retain only 50 percent.

"Splicing" means the joining of two separate lines. It also means the retracing of the unlaid strand of the line back through its own strands in the standing part of the line.

Four general types of splices in fiber line are commonly used in rigging work. They are the eye splice, short splice, long splice, and back splice. Once you learn how to make one type, the others should not be difficult.

Eye Splice

The principal use of an EYE SPLICE is to make an eye in the end of a line. The eye is useful in fastening the line to a ring or hook. It can also be made up with a thimble. A thimble is a grooved ring that may be set in the eye of a line to prevent chafing. The eye splice is estimated as being 90 percent as strong as the line itself.

To make an eye splice, you UNLAY (untwist) the strands in the end of your line about five turns, and splice them into the standing part of the line by TUCKING the unlaid strands from the end into the standing part. An original round of tucks plus two more complete rounds is enough for an ordinary eye splice.

With large lines, you must whip the ends of your strands before you start; otherwise, they will frazzle out and cause you trouble. Large lines must also be seized at the point where unlaying stops or you will have trouble working them. With any lineup to about 2 inches (50 mm), you can open the strands in the standing part with your fingers.

With larger lines, you use the fid. A fid is a tapered and pointed tool made from maple, hickory, or other hardwood. Figure 4-23 shows you the knack of working the fid in making an eye splice. Lay your line out along the deck with the end to your right. Bend it back until your eye is the size you want it, and shove the fid through the standing part at the right spot to raise the top strand. Shove the fid through the rope AWAY from you with your right hand as you hold the line with your left. Take the raised strand with your

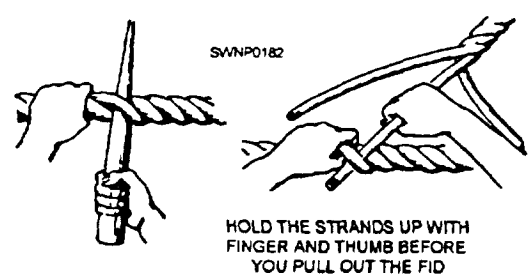


Figure 4-23.—Working the fid

left finger and thumb and hold it up while you pull out the fid. Drop the fid, pick up the proper strand in the end, and tuck it through the raised strand from outboard TOWARD you, as shown in the figure.

Your first round of tucks must be taken in proper order or you will come out all fouled up. Separate the strands in the end and hold them up, as shown in figure 4-24, view 1. The middle strand facing you always tucks first. Be sure you keep the right-hand strand (view 2) on the side of the line which is toward you. You tuck that one next, over the strand you just tucked the other one under, and under the strand just below it (view 3).

Now turn the whole thing over. You can see (view 4) that you now have only one strand from the end left untucked, and only one strand in the standing part that does not already have a strand under it. Be sure you tuck your last strand also from outboard toward you, as shown in view 5.

The first round of tucks is the big secret. The rest is easy. Simply tuck each strand from the end over the strand of the standing part which it is now above, and under the next strand below that one, until you have

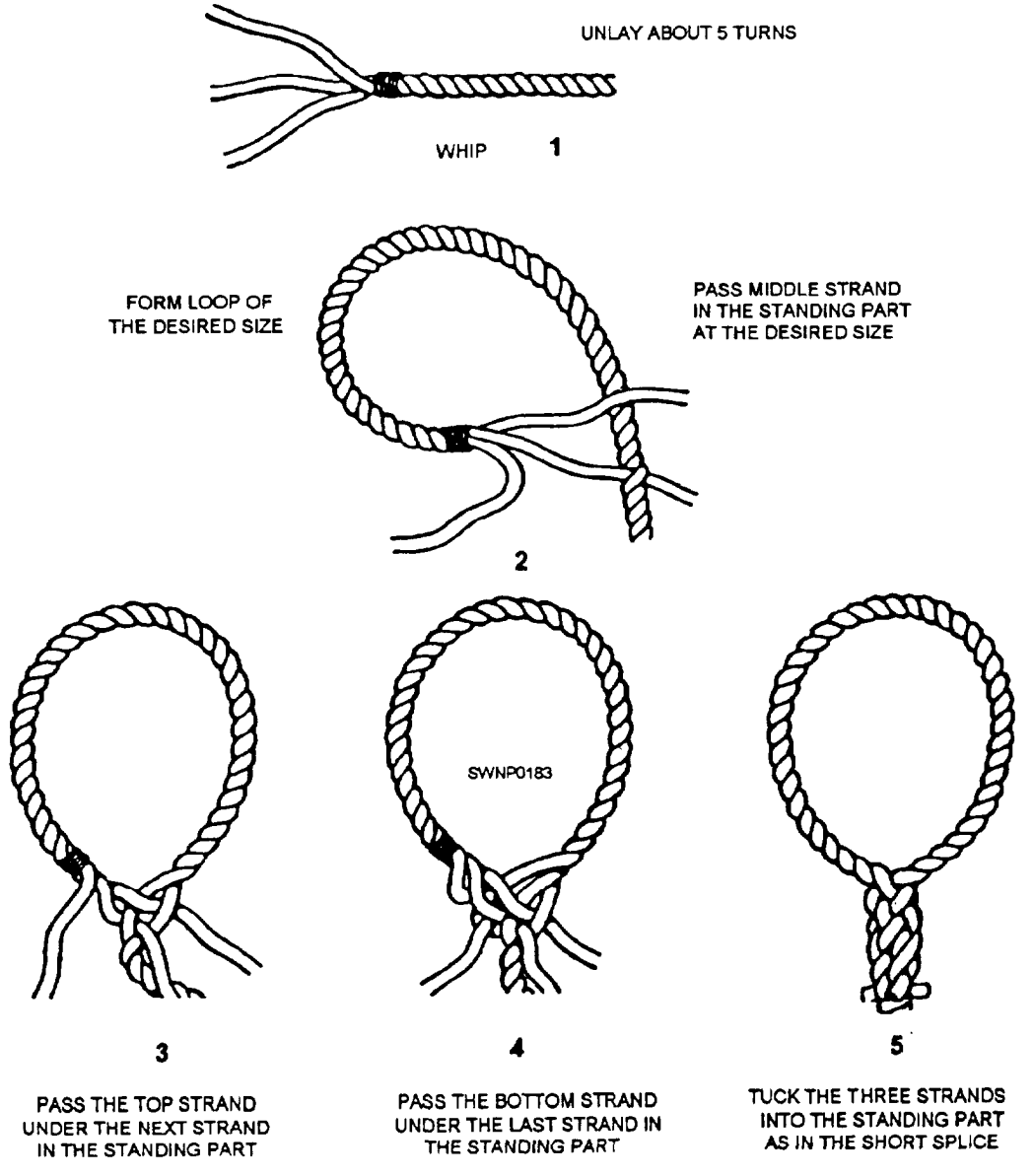


Figure 4-24.—Making an eye splice.

tucked each strand twice more besides the original tuck. Three tucks to each strand in all is enough.

Short Splice

In a SHORT SPLICE, the ends of a line are joined together or the ends of two different lines are joined, causing an increase in the diameter of the line for a short distance. This splice should NOT be used where the increase in the diameter of the line would affect operation. One purpose for which you may find the short splice especially useful is in making endless slings. It is also used for making straps. Slings and straps are made of pieces of line with their own ends short-spliced together. Where possible, a short splice, rather than a long splice, should be used. The reason is that the short splice requires less line and can be fashioned quicker than the long splice.

In making a short splice, unlay both ends of the lines about seven turns (fig. 4-25, view 1) and put a temporary whipping on each of the loose strands. The next step involves "marrying" the ends together. In marrying, the technique is to interlace the loose strands of one line with the loose strands of the other line. When this is completed properly, each loose strand should be between the two loose strands of the other line. With the strands in this manner, start making the tucks, following the principle of "over one and under one" (view 2). One side of the splice car be made with three tucks, and then the other side will be made identically. Three complete tucks of each

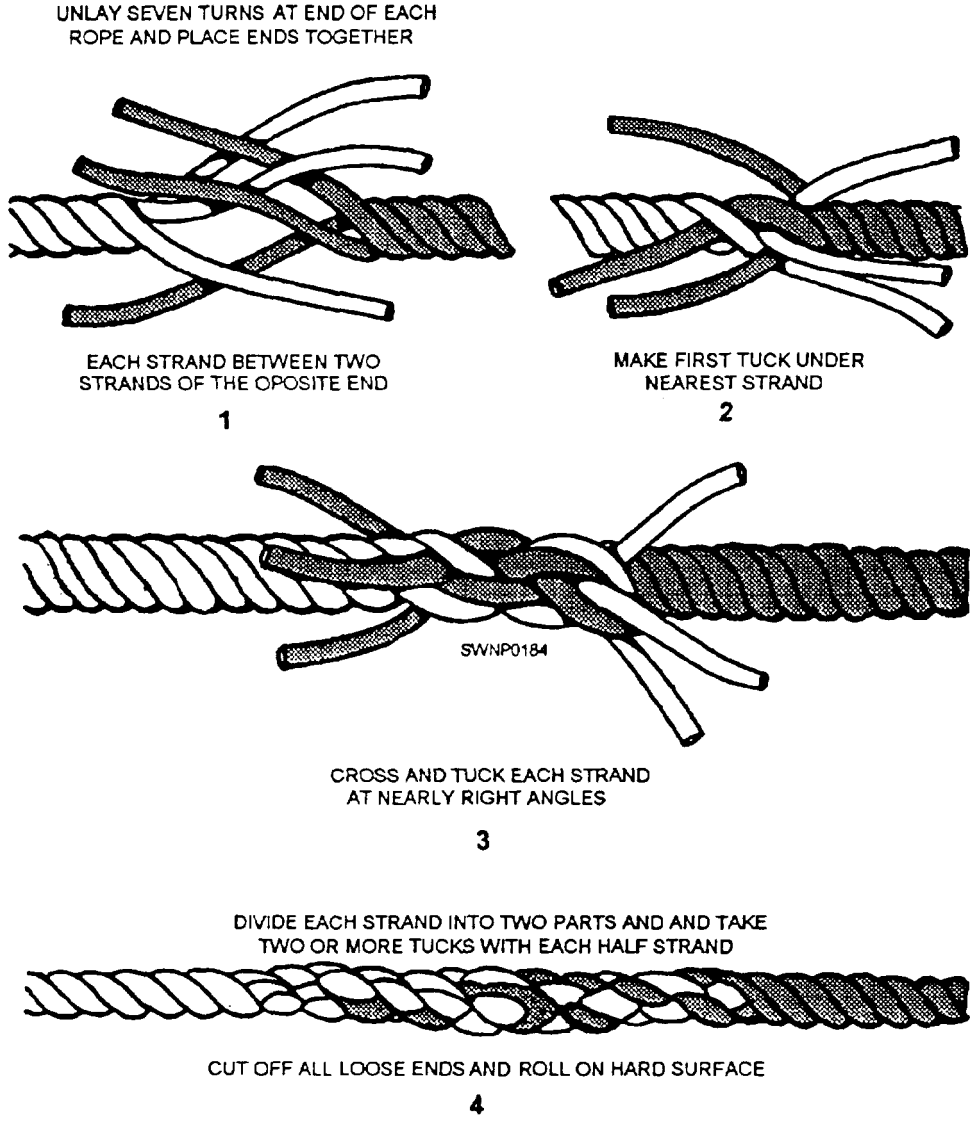


Figure 4-25.—Making a short splice.

strand should be sufficient to ensure a safe splice (view 3). As a finishing touch, cut off all loose ends and roll and pound the splice on a hard surface (view 4).

Long Splice

In a LONG SPLICE, either the ends of a line are joined together or the ends of two different lines are joined without increasing the diameter of the line. The strength of a properly made long splice will be equal to that of the line itself. The long splice is ideal for joining two lines where the line will be run over pulleys in a block. A short-spliced line would not serve this purpose since the diameter of the line at the point of splicing is larger than that of the remaining portion and may not pass over the pulleys in the block properly. The long splice also has a neater appearance than the short splice.

To make a long splice, unlay the ends about 15 turns and arrange the strands as shown in figure 4-26, view 1. Using two opposing strands, begin unlaying one and follow immediately laying its opposing strand tight into the left groove (fig. 4-26, view 2). Be sure you choose the correct pairs of strands for opposites. This is important. To determine the correct pair, try laying one of the tucking ends into the opposite standing line. The strand that this tucking end tends to push out and replace will be the correct opposing strand. In the process of replacing one strand with its opposing tucking end, keep a close watch on the marriage back at the starting place. If the other loose tucking ends are allowed too much freedom, they will divorce themselves from the original marriage. This creates quite a puzzle for the splicer due to the fact that the lines do not fit up correctly, and no matter which two strands are chosen, the splicer seems to end up with a stranger between them or else the last tucking ends have two strands between them. Therefore, it is important to keep the marriage intact when replacing

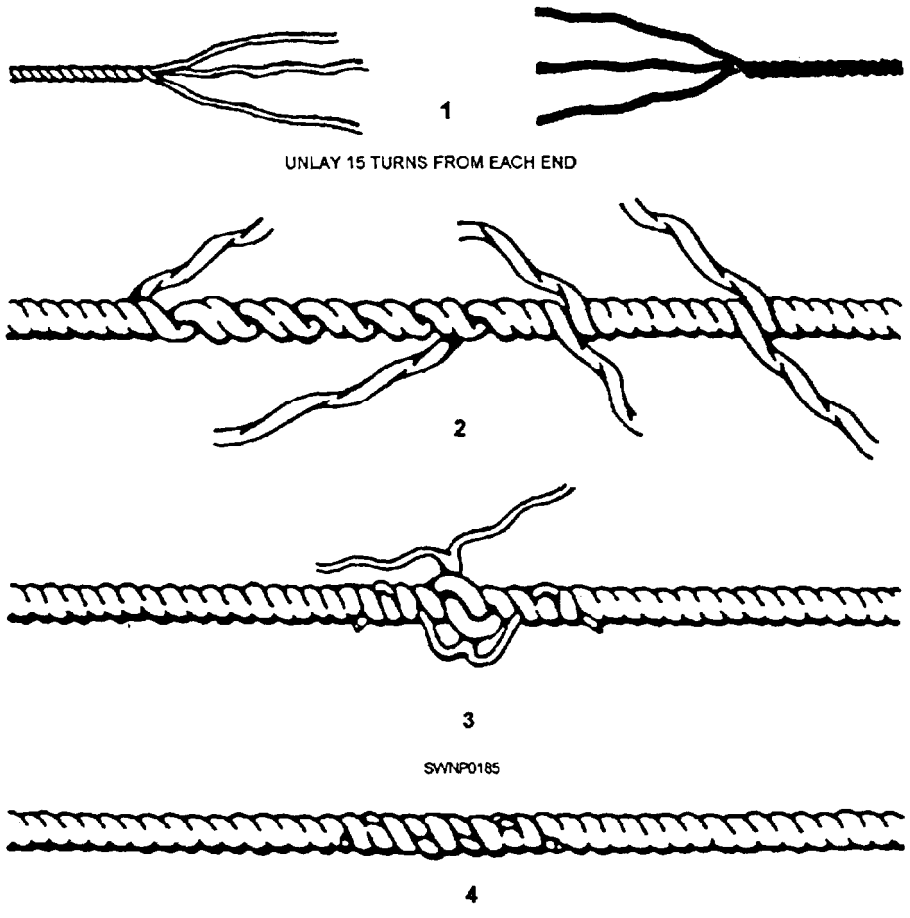


Figure 4-26.—Making a long splice.

one strand with another. Cut off all the remainders of the ends close up, then roll and pound the line so the tucks will settle in tight. As soon as you have gone far enough with the first tucking end to have its end left to make an overhand knot and two tucks, stop and tie the ends together. This procedure must be done in the correct direction; the ends must stand out away from the standing part, not alongside.

Now, select two more opposing strands from the marriage in the same manner as before. Be careful to pick the correct two strands. Proceed to unlay and replace (DOWN TIGHT) as you did the first pair-this time in the opposite direction. When the proper place is reached, tie a knot (view 3).

You now have two opposing strands with which you have nothing to do but make an overhand knot. If at this point there happens to be a standing strand running between them, a wrong choice has been made in choosing opposing strands (pairs) during one of the first two steps. The solution is to bring one or the other of these first two back and redo it with the correct pair. When completed, the splice should look similar to the example shown in view 4.

After all three overhand knots have been correctly tied, then start tucking all the loose ends over one and under one, twice each. Cut off all the remainders of the ends close up, then roll and pound the line so the tucks will settle in tight. When completed, the splice will look like view 4.

Back Splice

In a BACK SPLICE, the strands at the end of a line are spliced back into its own strands. This splice is used to prevent a line from unlaying or unraveling when an enlargement at the end of the line is not objectionable.

The back splice starts from a crown knot. The procedure for making aback splice is shown in figure 4-27.

After you have hauled the crown down tight by heaving on each of the three strands, proceed to lay up the back splice. This merely requires splicing the three loose strands back into the line, following the same principle as with the eye and short splice—over one and under one.

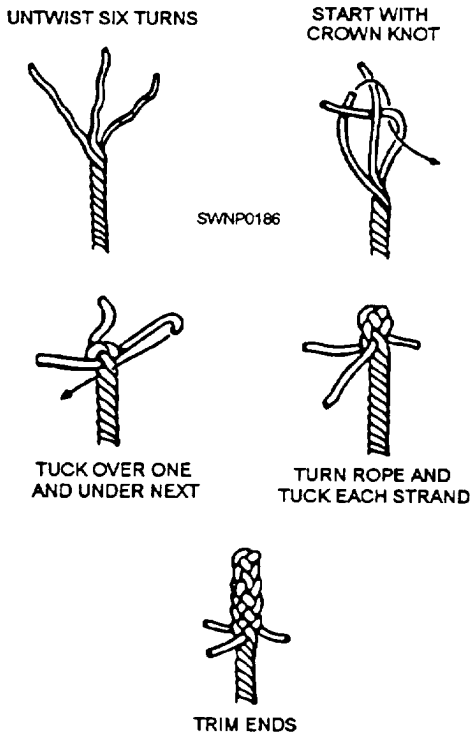


Figure 4-27.—Making a back splice

Because the back splice leaves a lump in the line, it should not be used where there is a possibility of the enlarged end hanging up, as might be the case if it were run through hoisting blocks.

SPLICING NYLON LINE

Nylon line can hold a load even when many strands are abraded. Normal] y, when abrasion is local, the line may be restored to use by cutting away the chafed section and splicing the ends. Chafing and stretching do not necessarily affect the load-carrying ability of nylon line.

The splicing of nylon line is similar to that of manila; however, friction tape is used instead of seizing stuff for whipping the strands and line. Because it is smooth and elastic, nylon line requires at least one tuck more than does manila. For heavy loads, a back tuck should be taken with each strand.