



## Boat Crew Seamanship Manual

# Chapter 7: Marlinspike Seamanship

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### Introduction

Marlinspike seamanship is the art of handling and working with all kinds of line or rope. It includes knotting, splicing, and fancy decorative work. There is no measure of a sailor's worth than skill in marlinspike seamanship. Much practice is required to become proficient in this skill. Knowledge of line handling terminology, phrases, and standard communication among the crew is necessary. To be less than proficient may be costly when the safety of line and property depends on the crew's knowledge of marlinspike seamanship.

This chapter discusses the following information:

- Types, characteristics, and care of line.
- Definitions.
- Safety practices.
- Line handling commands.
- Directions for tying knots.
- Instructions about basic boat line handling.
- Technical information for determining which line, hooks, and shackles are safe to use.

### In This Chapter

This chapter contains the following sections:

| Section | Title  | See Page |
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| A       | Types and Characteristics of Line                      | 2        |
| B       | Inspection, Handling, Maintenance, and Stowage of Line | 7        |
| C       | Breaking Strength (BS) and Working Load Limit (WLL)    | 14       |
| D       | Knots and Splices                                      | 17       |
| E       | Deck Fittings and Line Handling                        | 51       |

**WARNING:** The wearing of jewelry, including rings, wristwatches, necklaces or other items not consisting of organizational clothing, PPE, or uniform articles by boat crew members engaged in hoisting, towing, or other deck evolutions where the potential for snagging exists is strongly discouraged.

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## Section A. Types and Characteristics of Line

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### Introduction

The uses for a particular line will depend heavily upon the type and characteristics of the line. This section includes information regarding the different types of line used during boat operations.

### In This Section

This section contains the following information:

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| Natural Fiber Line   |          |
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### Line Characteristics

#### A.1. Composition

Lines are made of natural or synthetic fibers twisted into yarns. The yarns are grouped together in such a way as to form strands. Finally, the strands are twisted, plaited, or braided, in various patterns, to form line.

#### A.2. Division Line

Lines used on Division vessels are classified in three different ways:

- Size
- Breaking Strength
- Stretch

##### A.2.a. Size

No matter what the line is made of (natural or synthetic), it is measured the same way, by its diameter through the core and sleeve together. Depending on its size, the line is placed into one of the following three categories:

- Small stuff – up to 5/16" diameter
- Line – 3/8" up to ½"
- Large stuff – greater than ½"

##### A.2.b. Breaking Strength

Breaking strength is measured in pounds (weight load on the line). A 3/8 inch line with a breaking strength rating of 4,200 pounds will have a high failure rate at loads of 4,200 pounds or more.

NOTE: If your application will include knots, remember that many high-tech lines suffer about a 50% reduction in their working loads when tied, instead of spliced. Knowing how to splice is a useful rigging skill.

### **A.2.c. Stretch**

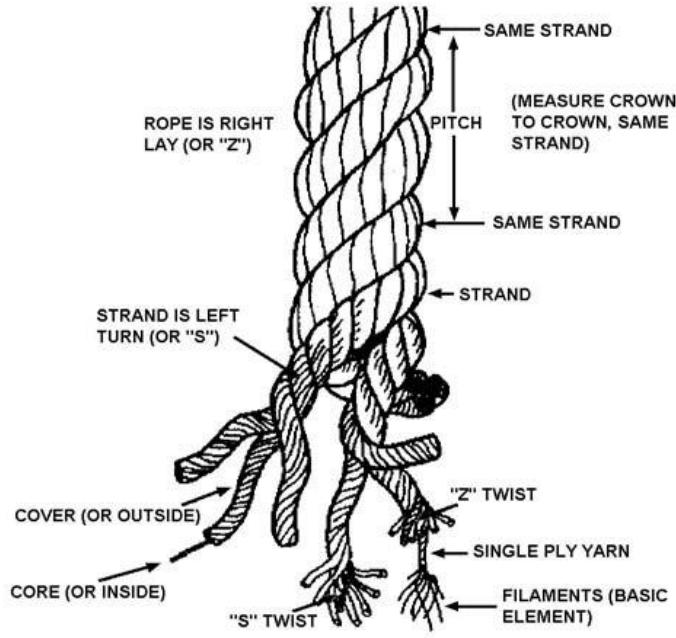
Stretch is a rating of how much a line will stretch under load. Many high tech racing sailboats prefer a small diameter line (for reduction of weight) with a stretch rating that is almost no stretch. These lines are very strong with a very high rating strength (even greater than cable of the same diameter). But they are also very expensive. Most division vessels use a line that is called “Low Stretch” or “Ultra Low Stretch”. These are very strong lines with minimal stretch under load. These lines are usually used for towing applications.

For securing to a dock or for anchoring a line with a little more stretch is preferred so that it will give some “shock absorber” affect so as not to put too much stress on anchoring or docking cleats.

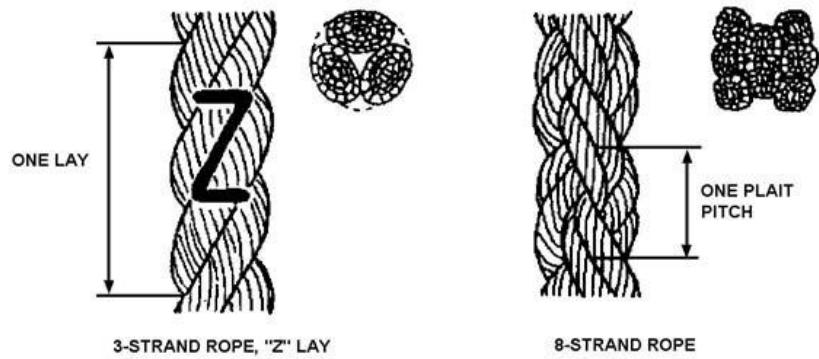
### **A.2.d. Construction**

Strands are twisted to either the right or the left. This twisting is the “lay” of the line. Lines may have either a left lay or a right lay depending upon how the strands are twisted together. Line is usually constructed as plain-laid, plaited, and double-braided lines. **Figure 7-1** illustrates fiber rope components and construction. The types of construction will depend upon the intended use of the line. The following describes line types:

| Line Type      | Characteristics  |
|----------------|--|
| Plain-laid     | Made of three strands, right- or left-laid. Most common is right hand laid.  |
| Cable-laid     | Made of three, right-hand, plain-laid lines laid together to the left to make a larger cable.  |
| Plaited        | Made of eight strands, four right-twisted and four left-twisted. Strands are paired and worked like a four strand braid  |
| Braided        | Usually made from three strands (sometimes four) braided together. The more common braided lines are hollow-braided, stuffer-braided, solid-braided, and double-braided  |
| Double-braided | Made of two hollow-braided ropes, one inside the other. The core is made of large single yarns in a slack braid. The cover is also made of large single yarns but in a tight braid that compresses and holds the core. This line is manufactured only from synthetics, and about 50% of the strength is in the core. |



THREE-STRAND ROPE COMPONENTS



**Figure 7-1**  
**Fiber Rope Components and Construction**

## Synthetic Fiber Line

### A.3. Composition

Synthetic fiber line is made of inorganic (man-made) materials. The characteristics of synthetic fiber line are considerably different from natural fiber line. The difference will vary depending on the type of material from which the line is made. The following identifies the various types of synthetic fiber lined used:

| Type                           | Characteristics   |
|--------------------------------|---|
| Nylon                          | A synthetic fiber of great strength, elasticity, and resistance to weather. It comes in twisted, braided, and plaited construction, and can be used for almost any purpose where its slippery surface and elasticity is not a disadvantage. |
| Dacron                         | A synthetic fiber of about 80% of the strength of nylon that will only stretch 10% of its original length   |
| Polyethylene and Polypropylene | A synthetic fiber with about half the strength of nylon 25% lighter than nylon making it easier to handle, and it floats in water.  |

### A.4. Commonly Used Types

The most common types of synthetic line used on Division vessels are nylon and polypropylene. Because of its superior strength and elasticity, nylon is used where the line must bear a load.

#### A.4.a. Double-Braided Nylon Line

Double-braided nylon line is the only line used for towlines on Division vessels. When double-braided line is made, the yarns are woven together much like the individual yarns in a piece of cloth are woven. The actual line consists of two hollow braided lines, an inner core and an outer cover. The core is woven into a slack, limp braid from large single yarns. The cover is woven from even larger yarns into a tight braid to cover and compress the core.

##### A.4.a.1. Advantages

Double-braided nylon has two other characteristics that increase its strength, elongation and elasticity. Elongation refers to the stretch of the line and elasticity refers to the ability of the line to recover from elongation. Synthetic line will stretch farther and recover better than natural line. Because of this, synthetic line can absorb the intermittent forces and surges resulting from waves or seas much better than natural fiber line.

##### A.4.a.2. Limitations

While its superior strength makes double-braided nylon line the preferred choice for load bearing, there are disadvantages. Because it will stretch further (elongate) and still recover (elasticity), the snap back potential if the line parts is greater than with natural fiber line. Also, if nylon line is doubled and placed under excessive strain, there is a danger that the deck fittings might fail. If that happens, the line will snap back like a rubber band, bringing the deck fitting with it.

**CAUTION:** Never double a line or use a single line that can withstand more pulling force than the bollard pull of the towing bitt.

#### **A.4.a.3. Bollard Pull**

Bollard pull is the point where the static pulling force becomes such that any increase in engine load could lead to damage to the engine or the towing bitt.

#### **A.4.b. Plain-Laid Polypropylene Line**

Orange-colored polypropylene line is used on Division vessels for life rings and heaving lines.

##### **A.4.b.1. Advantages**

The advantage to this line are high visibility and flotation.

##### **A.4.b.2. Limitations**

The main disadvantage of plain-laid polypropylene line is lack of strength compared to nylon line of equal size. Its loose, coarse weave makes it easy to splice but susceptible to chafing. Aggravating this is polypropylene's characteristics of deteriorating rapidly when exposed to continued sunlight. It can, in fact, lose up to 40% of its strength over three months of exposure. For this reason, the line is best kept covered when not in use, and inspected and replaced on a regular basis.

#### **A.5. Slippage**

Synthetic line slips much easier than natural line. Because of this, it will slip through deck fittings and will not hold knots as well. Care should be taken when bending synthetic line to an object or to another line to ensure the knot will not slip out. One way to help prevent this is to leave a longer tail on the running or bitter end than with natural fiber line.

**CAUTION!** To minimize the hazard of being pulled into a deck fitting when a line suddenly surges, ensure all crewmembers stand as far as possible from the equipment. Work the lines with hands at a safe distance from the fittings. This is particularly important during towing operations.

#### **A.6. Considerations**

When using synthetic lines consider the following:

- Synthetic lines slip easily. Use caution when paying it or surging it form deck fittings.
- Beware of slippage when bending synthetic line together or securing.
- Never stand in a position where exposed to the dangers of snap back if the line parts.
- Do not double up the line during a towing operation.
- Keep working surfaces of bitts free of paint and rust.
- Do not stand in the bight of a line or directly in line with its direction of pull.

#### **A.7. Cutting**

The use of a hot knife is the preferred method for cutting nylon and polypropylene line. Using a hot knife eliminates the need for burning the ends. Commercial electric knives, sued by sail makers, are available. Some soldering irons can be fit with blades for cutting line. One of the more common methods is to heat an old knife or scraper using a propane torch.

When cutting the line, the blade or saw should not be forced through the line, as the heat will do the job. The best method is to work from the outside in. First, an incision is made around the circumference of the line, and then a cut is made through the center.

NOTE: Remember, when a piece of rope is cut, it will fray. Always finish the end of the line whether before or immediately after cutting the line.

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## Section B. Inspection, Handling, Maintenance, and Stowage of Line

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### Introduction

Proper maintenance and inspection of line is vital to the completion of the mission as well as the safety of the crew. If a line is damaged or not properly maintained, it could fail, resulting in possible damage to property and/or injury to personnel. This section provides the necessary information regarding basic inspection, uncoiling and unreeling, maintenance, and stowage of line.

### In This Section

This section contains the following information:

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| Uncoiling and Unreeling | 9        |
| Maintenance             | 10       |
| Stowing Lines           | 12       |

## Inspection

### B.1. Description

A periodic inspection of all lines used should be made, paying special attention to the following items:

- Aging.
- Fiber wear.
- Fiber damage.
- Chafing.
- Kinks.
- Cockles.
- Cutting.
- Overloading or shockloading.
- Rust/foreign materials.
- Eye splices.

CAUTION: Synthetic double-braided line should not be taken apart for inspection.

## B.2. Aging

Aging is not a significant problem for nylon line, though it will change its color with age. As stated before though, polypropylene line does not deteriorate rapidly when exposed to sunlight.

## B.3. Fiber Wear

Fiber wear is not a significant problem for nylon line, [except at the Great Salt Lake, where salt can penetrate into the core. The dried up salt crystals can act like hundreds of little razors wearing down the fiber.](#)

## B.4. Fiber Damage

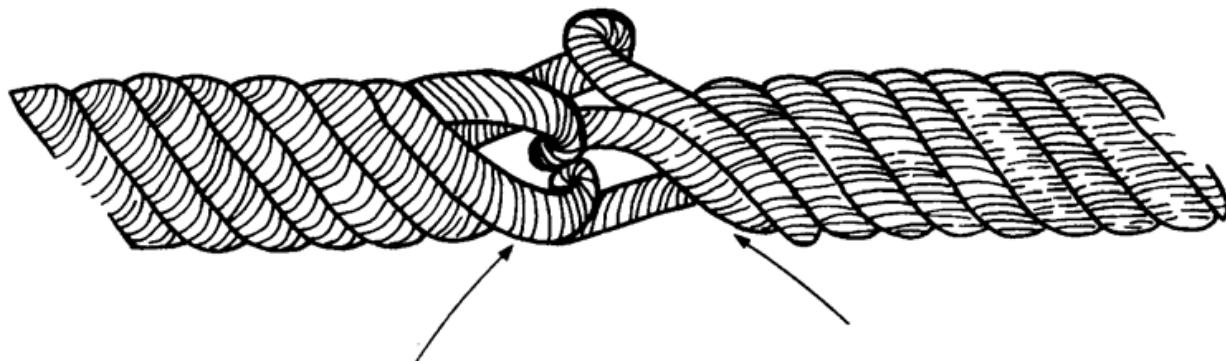
With synthetic line, some of the individual synthetic fibers of the line may break if overloaded. These will be visible on the outer surface of the line. [As stated earlier, Salt at the Great Salt Lake can also act on the internal core fibers of the line.](#)

## B.5. Chafing

Chafing is wear affecting the outer surface of the line, caused by the friction of the line rubbing against a rough surface. To check for chafing, the outer surface of the line should be visually inspected for frayed threads and broken or flattened strands. Chafing can also cause hardening and fusing of the outer layer.

## B.6. Kinks

A kink (See **Figure 7-2**) is a twist or curl caused when the line doubles back on itself. A line with a kink should never be placed under strain. The tension will put a permanent distortion in the line. All kinks should be removed before using a line.



**Figure 7-2**  
Line with a Kink

## B.7. Cockles

A cockle (or hackle) is actually a kink in an inner yarn that forces the yarns to the surface. Cockles can be corrected by stretching the line and twisting the free end to restore the original lay. A cockle can reduce line strength by as much as a third. In braided line this is very rare but some manufacturers have been known to inadvertently twist one inner core braid too tightly causing cockles over time.

## B.8. Cutting

Cutting damage found on line is similar to chafing, but occurs when the line rubs against a sharp edge rather than a rough surface. This will give the appearance as if the line was cut with a knife. Cutting

damage to yarns and threads will greatly reduce the effectiveness of the line and can cause failure under strain.

**WARNING:** DO NOT stand directly in lie behind a line under strain! If the line were to part, it could snap back and cause injury.

#### **B.9. Overloading or Shock-Loading**

Signs that a line was overloaded are elongation and hardness. Lines stretched to the point where it will not come back has a decreased diameter. To determine this, the crewmember should place the line under slight tension and measure the circumference of a reduced area and of normal areas. If the circumference is reduced by five percent or more, the line should be replaced.

Another indication of synthetic line overloading is hardness to the touch. This can be noticed while gently squeezing the line. Overloaded line should not be used.

A line under strain is dangerous. If it parts, it will do so with a lot of force, depending on the size and type of line, and how much strain it is under when it parts. As a general rule, when a line is under stress, it is important to always keep an eye on it. Standing in line with the strain may cause serious injury if the line parts and snaps back.

#### **B10. Rust/Foreign Material**

Rust strains, extending into the cross-section of natural fiber and nylon fiber yarns can lower line strength as much as 40%.

Foreign materials (sand, dirt, paint chips, etc.) can get lodged inside the fibers of a line. Once inside the line and under strain, these materials can cause abrasive damage to the line. Care should be taken to cover up lines to prevent foreign materials from entering if they are stowed or in use near work areas.

#### **B.11. Eye Splices (Double-Braided Nylon Line)**

Prior to each use, all eye splices should be inspected on working lines (towline, anchor rode, mooring lines, etc.). Crewmembers should pay particular attention to the area of the line that is tucked back in on itself, ensuring there are no “flat spots” or areas where the inner core has slipped away leaving only the outer cover. The entire eye should be inspected for chafing and cuts.

### **Uncoiling and Unreeling**

#### **B.12. Description**

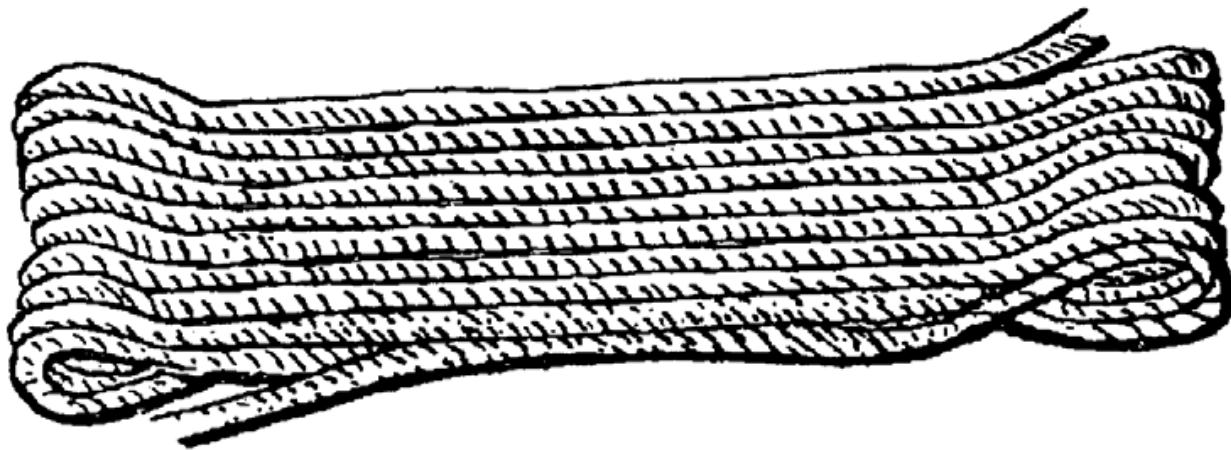
Proper use and care will significantly extend the lifetime of the lines used. Everyone should be responsible for protecting lines from damage. Along with good inspections, some of the ways to accomplish this are proper breakout, stowage, and care.

#### **B.13. Unreeling Synthetic Fiber Line**

The recommended method for unreeling synthetic fiber lines is to:

- Insert a pipe through the center and hang the reel off the deck.
- Draw the line from the lower reel surface.

Twisted fiber lines should not be “thrown” off the reel, as this will cause tangles and kinks. It is recommended that three-strand synthetic lines be faked down on a deck and allowed to relax for twenty-four hours. Lengths less than 50- feet will relax in one hour when laid out straight. Fake down double-braided lines in figure eight patterns. (See **Figure 7-4**)



**Figure 7-4**  
**Line Faked Down**

## Maintenance

### **B.13. Description**

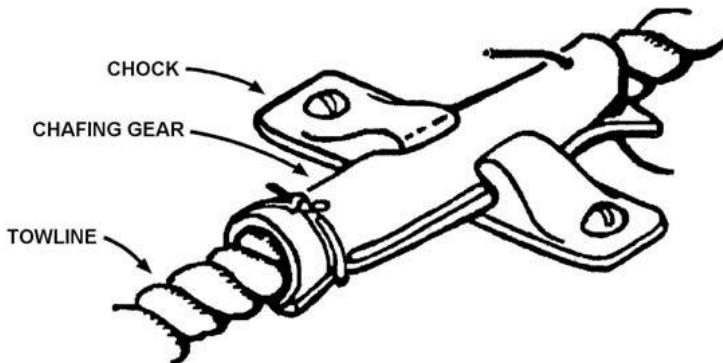
While there is nothing that can be done to restore bad line, precautions can be taken to extend the life of lines.

### **B.14. Keeping Lines Clean**

Lines should be kept free from grit or dirt. Gritty material can work down into the fibers while a line is relaxed. Under tension, the movement of the grit will act as an abrasive and will cause serious damage to the fibers.

### **B.15. Using Chafing Gear**

Chafing gear can be made of old hoses, leather, or heavy canvas. It is used to protect short pieces of line where they run over taff rails, chocks, or other surfaces. (See **Figure 7-5**)



**Figure 7-5  
Chafing Gear**

#### **B.16. Keeping Deck Fittings Clean and Smooth**

Bitts, cleats, and chock surfaces should be kept smooth to reduce line abrasion.

#### **B.17. Watching for Frozen Water**

Crewmembers should ensure that water does not freeze on lines. Ice is abrasive and can cut fibers.

#### **B.18. Avoiding Crushing or Pinching Lines**

Crewmembers should avoid walking on, placing loads on, dragging loads over, or in other ways crushing or pinching a line.

#### **B.19. Being Caution of Sharp Bends**

Bending under a load causes internal abrasion between the strands of the line. If a line has to go around something, a fair lead should be used. A fair lead is any hole, bull's-eye, lizard, suitably placed roller, sheave, etc., serving to guide or lead a rope in a desired direction. It is important to remember that if a fair lead is not used, the bigger the bend, the less abrasive effect.

#### **B.20. Care of Synthetic Fiber Line**

| <b>Do's</b>   | <b>Don'ts</b>  |
|---|--|
| <ul style="list-style-type: none"> <li>• Dry line before stowing it.</li> <li>• Protect line from weather when possible.</li> <li>• Use chafing gear (canvas, short lengths of old hoses) where line runs over sharp edges or rough surfaces.</li> <li>• Slack off taut lines when it rains. Wet lines shrink and if the line is taut, the resulting strain may be enough to break some of the fibers.</li> <li>• Reverse turns on winches periodically to keep out the kinks.</li> <li>• Lay right-handed lines clockwise on reels or capstans and left-laid lines counterclockwise until they are broken in.</li> <li>• Inspect lines for fiber damage and other</li> </ul> | <ul style="list-style-type: none"> <li>• Stow wet or damp line in a unventilated compartment or cover it so that it cannot dry.</li> <li>• Subject the line to intense heat.</li> <li>• Subject a line to loads exceeding its working load limit.</li> <li>• Allow line to bear on sharp edges or run over rough surfaces.</li> <li>• Put a strain on a line with a kink on it.</li> <li>• Let wear become localized in one spot.</li> </ul> |

|  |  |
|--|--|
| <p>wear conditions before each use.</p> <ul style="list-style-type: none"> <li>• Try to tie knots or hitches in new places as much as possible so as not to wear out the line.</li> <li>• Occasionally end-for-ending (swap one end for the other) to help reduce excessive wear at certain points.</li> <li>• If it becomes slippery with oil or grease, it should be scrubbed with a 10% mild solution of detergent/degreaser and water (fresh water – not salt water).</li> </ul> |  |
|--|--|

## Stowing Lines

### B.21. Description

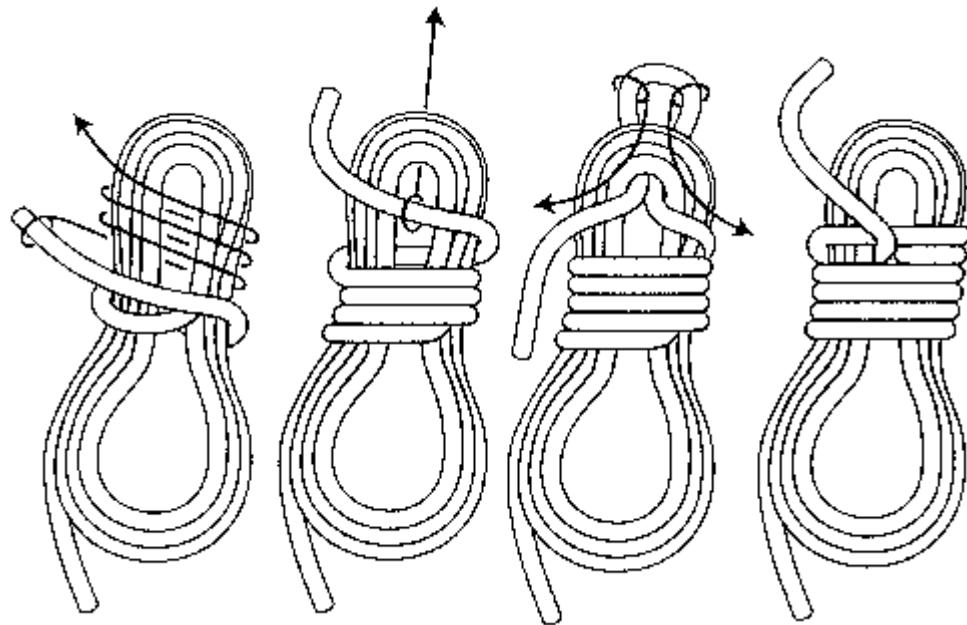
To prevent the deteriorating effects of sunlight, chemicals, paints, soaps, and linseed or cottonseed oils, lines should be stored to prevent contact with harmful items or conditions.

### B.22. Synthetic Fiber Lines

Synthetic fiber lines are not as susceptible to the effects of moisture as natural fiber lines. They are, however, affected by all of the other conditions and materials that will hurt line. The boat's towline and other synthetic lines should be kept covered or stored in a dark area, when not in use.

Synthetic lines should not be constantly coiled in the same direction, as doing this tends to tighten the twist. Three-strand synthetic line is often coiled clockwise to reduce a natural tendency to tighten up. It can be coiled in figure eights to avoid kinks when paying out. (See **Figure 7-6**)

Whereas synthetic line stretches when put under a load, allow plenty of time for the line to recover to its original length before coiling on a drum or reel.



**Figure 7-6**  
**Figure Eight Coils**

**B.23. Towline**

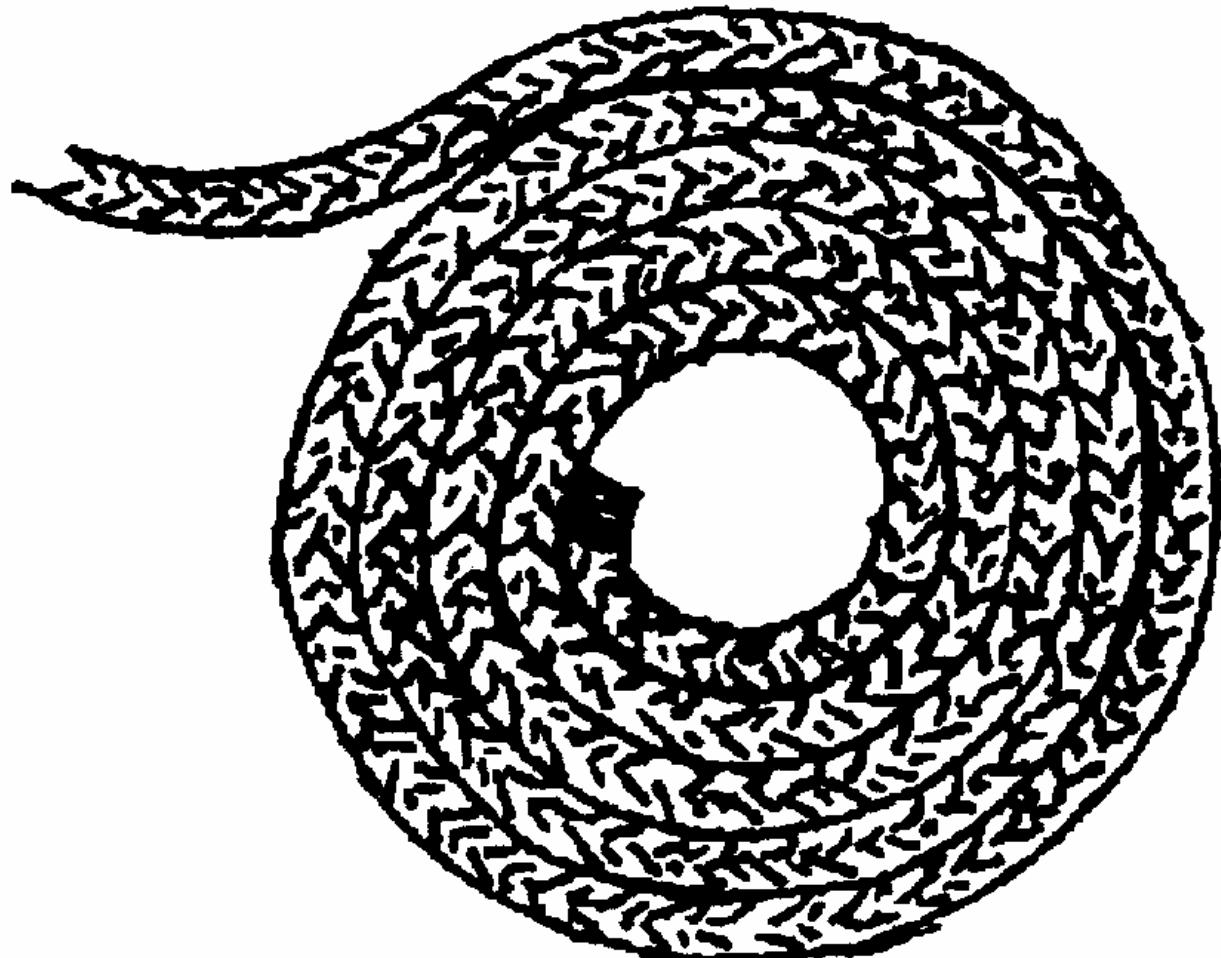
See *Chapter 17, Towing* for procedures to stow towlines.

**B.24. Coiling**

The most common method of stowing the extra line on deck or on the dock after making fast to a cleat is to coil it.

**B.24. Flemishing a Line**

Flemishing a line consists of coiling a line clockwise against the deck. It is used for appearance (e.g., inspections, seaman-like appearance). See **Figure 7-7**



**Figure 7-7**  
**Flemishing a Line**

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## Section C. Breaking Strength (BS) and Working Load Limits (WLL)

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### Introduction

This section provides the basic information on breaking strength (BS) and working load limits (WLL) of a line. For specific breaking strength or working load limits, consult the supplier (manufacturer) of the line.

### In This Section

This section contains the following information:

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| Understanding BS and WLL for Shackles and Hooks  | 15       |
| Considerations and Limitations                   | 17       |

## Understanding the Basics of BS and WLL of a line

### **C.1. Description**

A line stretches as it takes on a load. It will continue to do so as tension increases until it reaches its breaking point. Then it will part and snap back. There have been many injuries and deaths caused by lines snapping when working under tension. Safe line handling is a combination of knowledge and skill. Know the BS and WLL for the line being used on your Division vessel.

### **C.2. Breaking Strength (BS)**

The BS of a line is measured in the number of pounds of stress a line can take before it parts. It is a part of the technical information provided to the purchaser. The number comes from stress tests conducted by the manufacturer of the line as is an average of all the lines tested. BS is not exact for any specific line. A safety factor must be applied to determine the WLL of a line.

### **C.3. Working Load Limit (WLL)**

Line should be selected with its intended usage, or working load, in mind. A common seamanship practiced says that the WLL of a line should be not more than one-fifth of its BS, or that the BS should be five times the weight of the object attached to the line. This five-to-one safety factor allows for sudden strains, shock-loading, and normal deterioration as the line ages.

## Understanding BS and WLL for Shackles and Hooks

### **C.4. Description - Shackles**

Given a choice between the hardware breaking and the line parting, it is usually safer for the line to part. The BS of shackles is up to six times greater than their WLL

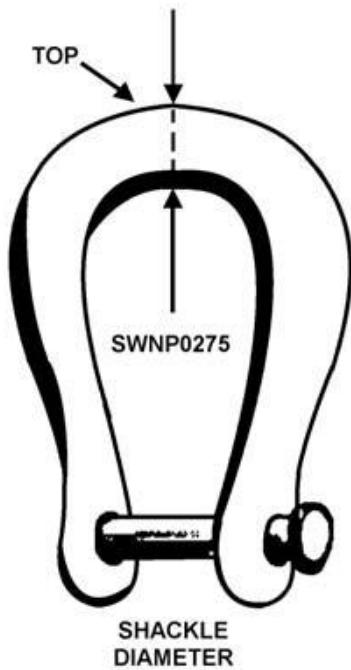
CAUTION! Never use a shackle or hook with a WLL less than the WLL of the line being used.

### **C.5. Determining WLL**

Since shackles and hooks are made of different materials (stainless, forged tempered steel) and they come in many different shapes and sizes, their BS and WLL will vary. There is no single set formula to determine the BS or WLL for all shackles and hooks. In most cases, the WLL will be stamped or molded directly into the hardware. Crewmembers should always refer to the manufacturer's specifications before use. A shackle or hook with a WLL less than the WLL of the line being used should never be used.

### **C.6 Damaged Shackles and Hooks**

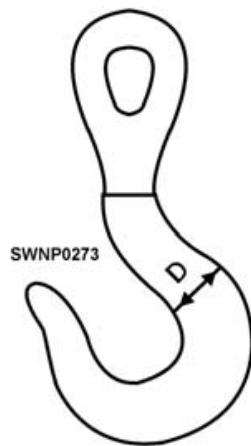
Manufacturer's specifications must always be followed and damaged, bent or severely rusted shackles must not be used. All shackles must be inspected before use.



**Figure 7-8**  
**Shackles**

#### C.7. Description – Hooks

Like shackles, the WLL of hooks is either found stamped or forged in the hook itself or form manufacturer's specifications. Damaged, bent, or severely rusted hooks shall not be used. All hooks shall be inspected for wear, deformity and cracks before lifting a load.



**Figure 7-9**  
**Hook**

## Considerations and Limitations

### C.8. Description

Even though the WLL of lines, shackles and hooks may be correctly determined, there are many variables affecting the equipment. In actual use, it is not always possible to operate within the WLL. Sometimes appropriate hardware cannot be matched with particular lines.

### C.9. Keeping Alert

It is necessary to keep a constant eye on a line under stress. Crewmembers should always remain on guard to prepare for the unpredictable, unforeseen and often dangerous forces in the marine environment. By using good judgment, timely adjustments can usually be made to correct for these adverse forces.

### C.10. Staying Within Limits

The tension on line and equipment should be kept well within their WLL. It is difficult to tell when the WLL is reached or surpassed. A sudden surging (pulling) of a towline may cause the tension on the line and hardware to approach their breaking points. This is when the danger of parting becomes a safety hazard.

### C.11. Unknown BS and WLL

The moment the towline is connected to a distressed vessel's deck fittings, the entire towing system assumes an unknown BS and WLL factor. A reliable estimate of BS and WLL often cannot be achieved even when the proper equipment is attached to the disabled craft. Because this is the weak link in towing, the towline and the boat in tow must be kept under constant observation.

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## Section D. Knots and Splices

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### Introduction

This section details the procedures regarding the art of knots and splices.

### In This Section

This section contains the following information:

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| Breaking Strength          | 18       |
| Basic Knots                | 19       |
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| Whipping                   | 47       |
| Mousing Hooks and Shackles | 49       |

## Estimating Length of a Line

### D.1. Procedure

Estimating the length of a line can be a useful skill. One method of doing so is as follows:

| Step | Procedure   |
|------|---|
| 1    | Hold the end of a length of line in one hand.   |
| 2    | Reach across with the other hand and pull the line through the first hand, fully extending both arms from the shoulder. |

The length of line from one hand to the other, across the chest, will be roughly six feet (one fathom). Actually, this distance will be closer to the person's height, but this measure is close enough for a rough and quick estimate of line needed.

If more line is needed, the process should be repeated keeping the first hand in place on the line as a marker until the length of line required has been measured off. For example, if 36' of line is needed, the procedure should be repeated six times.

## Breaking Strength

### D.2. Knots and Splices

Knots are used for pulling, holding, lifting, and lowering. When using line for these purposes, it is often necessary to join two or more lines together. Knots and bends are used for temporary joining, and splices provide a permanent joining. In either case the BS of the joined line is normally less than the BS of the separated lines.

The weakest point in a line is the knot or splice. They can reduce the BS of a line as much as 50 to 60 percent. A splice, however, is stronger than a knot. **Table 7-6** lists each of the commonly used knots and splices. It provides their percent of line BS lost and percent of line BS remaining.

**Table 7-6**  
**Percent of Line BS Loss**

| Knots or Splice Remaining | Percent of Line BS Lost | Percent of Line BS Remaining |
|---------------------------|-------------------------|------------------------------|
| Square                    | 46                      | 54                           |
| Bowline                   | 37                      | 63                           |
| Two Bowlines (Eye-in-Eye) | 43                      | 57                           |
| Becket Bend               | 41                      | 59                           |
| Double-Becket Bend        | 41                      | 59                           |
| Round Turn                | 30-35                   | 65-70                        |
| Timber Hitch              | 30-35                   | 65-70                        |
| Clove Hitch               | 40                      | 60                           |
| Eye Splice                | 5-10                    | 90-95                        |
| Short Splice              | 15                      | 85                           |

## Basic Knots

### D.3. Temporary Knots

Knots are the intertwining of the parts of one or more lines to secure the lines to themselves, each other (bends), or other objects (hitches). Because knots decrease the strength of the line, they should always be treated as temporary. If something permanent is needed, a splice or seizing can be used.

### D.4. Definitions

In making knots and splices, the crewmember must know the names for the parts of a line and the basic turns employed. Refer to **Figure 7-10** and **Figure 7-11** for an example of the following knots.

| Knot                     | Description  |
|--------------------------|--|
| Running End (Bitter End) | The running end (bitter end) or the free end of a line. It is the end of the line that is worked with.                                     |
| Standing Part            | The standing part is the line unused or belayed end of a line. It is the remaining part of the line, including the end that is not worked. |
| Overhand Loop            | The overhand loop is a loop made in a line by crossing the bitter end over the standing part.  |
| Underhand Loop           | The underhand loop is a loop made in the line by crossing the bitter end under the standing part.  |

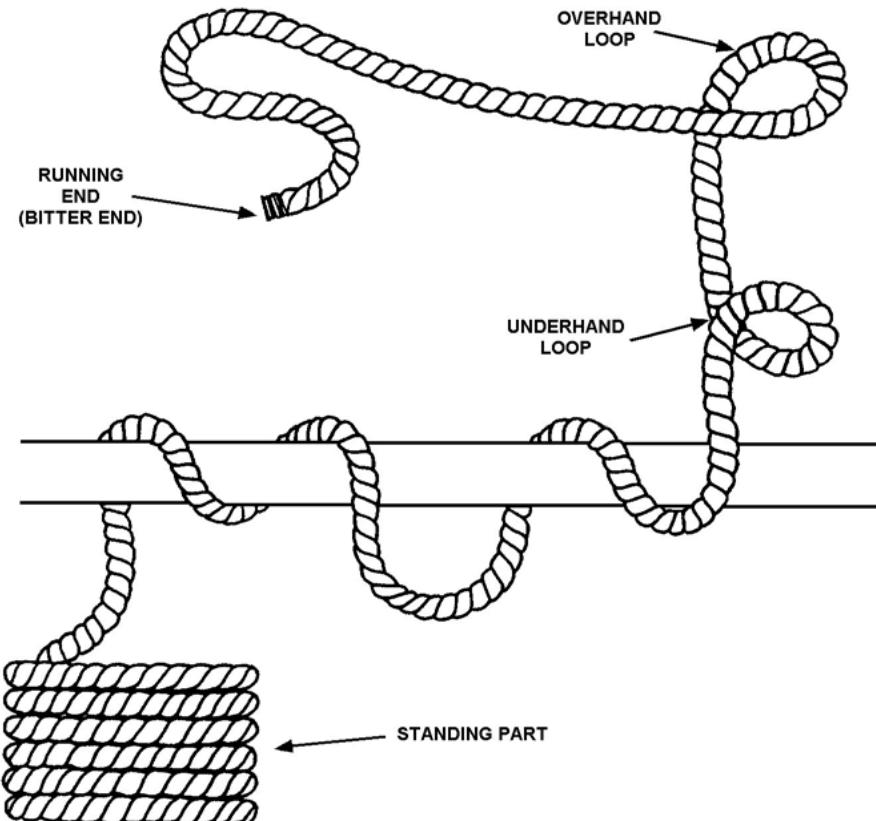
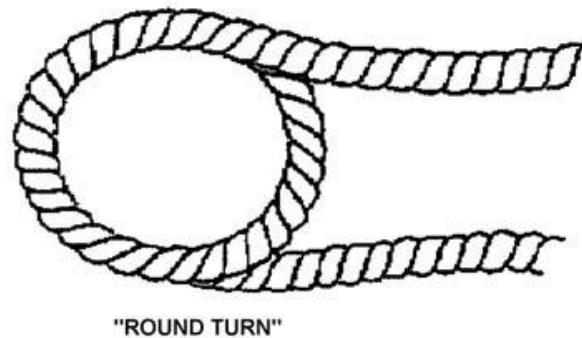
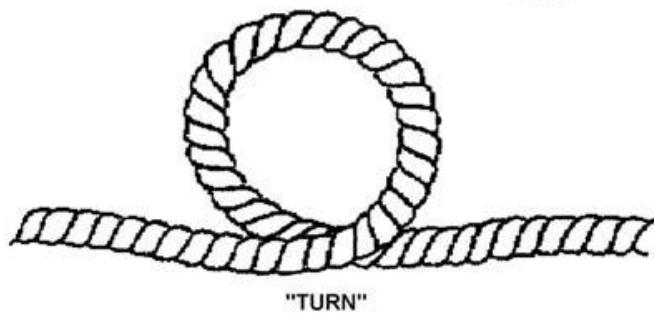
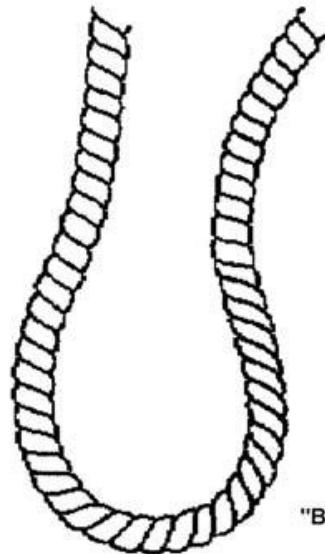


Figure 7-10

### **Basic Parts and Loops**

| <b>Knot</b> | <b>Description</b>  |
|-------------|---|
| Bight       | A bight is a half loop formed by turning the line back on itself.                                     |
| Turn        | A turn is a single wind or bight of a rope, laid around a belaying pin, post, bollard, or the like.   |
| Round Turn  | A round turn is a complete turn or encircling of a line about an object, as opposed to a single turn. |



**Figure 7-11**  
**Bight and Turns**

#### D.5. Anatomy of a Knot

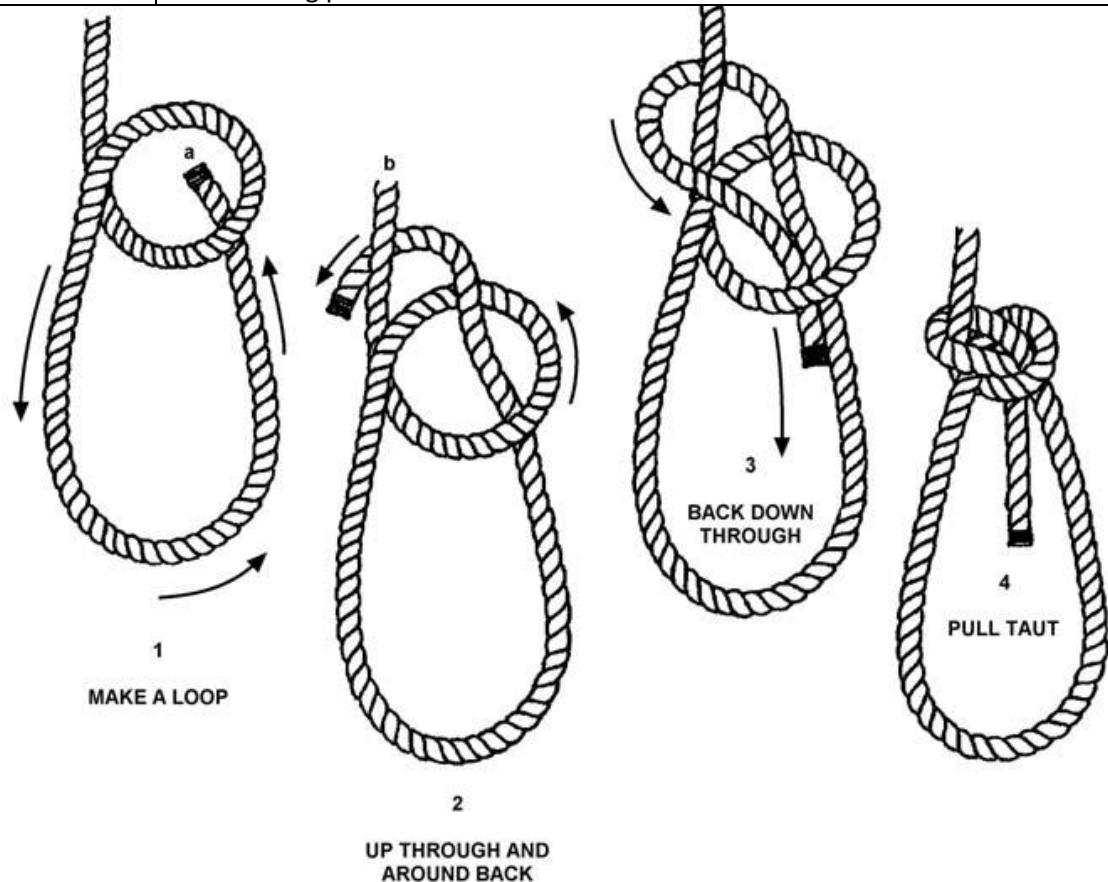
Good knots are easy to tie, are easy to untie, and hold well. A good knot will not untie itself. In sailing vernacular, a knot is used to tie a line back upon itself, a bend is used to secure two lines together, and a hitch is used to tie a line to a ring, rail, or spar. A knot used to secure a line to an object, such as a ring or eye, is a hitch. The knots listed below are those most commonly used in boat operations.

Crewmembers should learn to tie them well, for the time may come when the skill to do so could decide the outcome of a mission.

#### D.5.a. Bowline

The bowline is a versatile knot and can be used anytime a temporary eye is needed in the end of a line. It also works, for tying two lines, securely together, though there are better knots for this. An advantage of a bowline is that they do not slip or jam easily. Refer to **Figure 7-12** while performing the following procedures:

| Step | Procedure  |
|------|--|
| 1    | Make an overhand loop in the line the size of the eye desired.   |
| 2    | Pass the bitter end up through the overhand loop.  |
| 3    | Bring the bitter end around the standing part and back down through the overhand loop.                                     |
| 4    | Pull the knot tight by holding the bitter end and the loop with one hand, and pulling on the standing part with the other. |



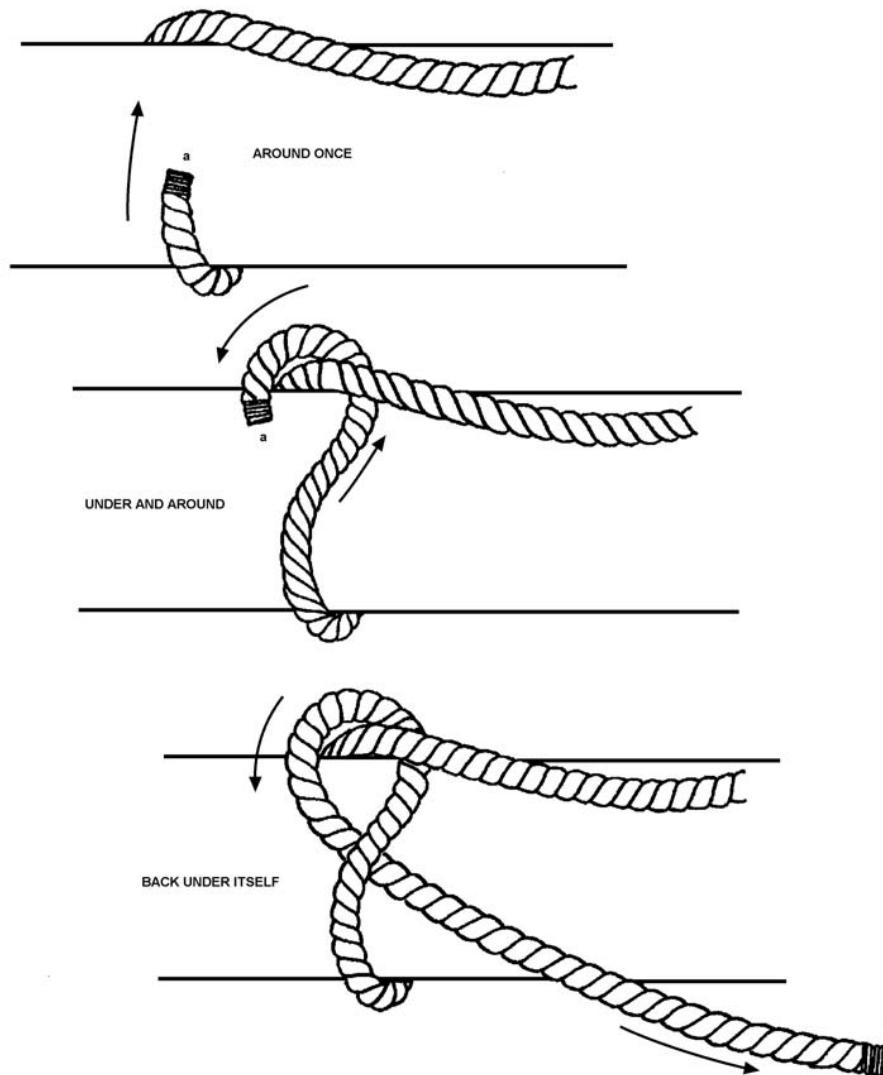
**Figure 7-12**

## Bowline

### D.5.b. Half Hitches

Hitches are used for temporarily securing a line to objects such as a ring or eye. One of their advantages is their ease in untying. The half hitch is the smallest and simplest hitch. It should be tied only to objects having a right-hand pull. Since a single half hitch may slip easily, care should be taken in cases where it will encounter stress. Refer to **Figure 17-13** while performing the following procedures:

| Step | Procedure   |
|------|---|
| 1    | Pass the line around an object.   |
| 2    | Bring the working end "a" around the standing part and back under itself. |

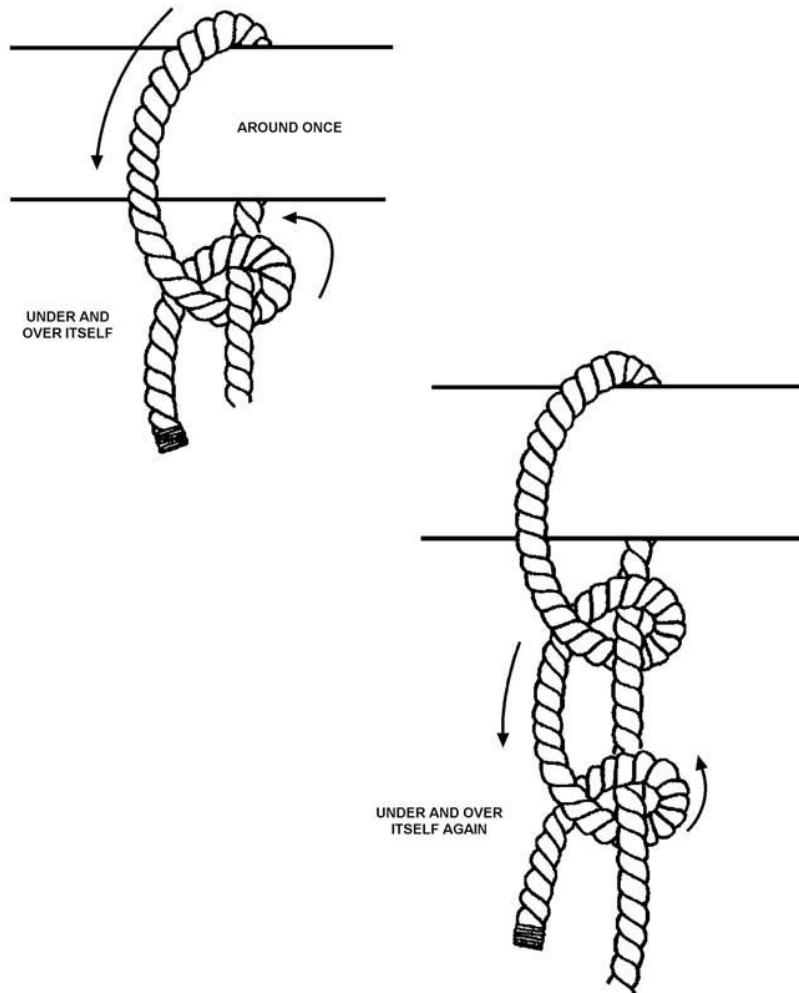


**Figure 7-13**  
**Half Hitch**

### D.5.c. Two Half Hitches

To reinforce or strengthen a single half hitch, the rope can be tied once more. Two half hitches make a more reliable knot than a single half hitch and can be used to make the ends of a line fast around its own standing part. A round turn or two, secured with a couple of half hitches, is a quick way to secure a line to a pole or spar. Two half hitches are needed to secure a line at an angle where it might slide vertically or horizontally. Refer to **Figure 7-14** while performing the following procedures:

| Step | Procedure  |
|------|--|
| 1    | Take a turn around the object.   |
| 2    | Bring the running end (bitter end) under and over the standing part and back under itself. |
| 3    | Continue by passing bitter end under and over the standing part and back under itself.     |

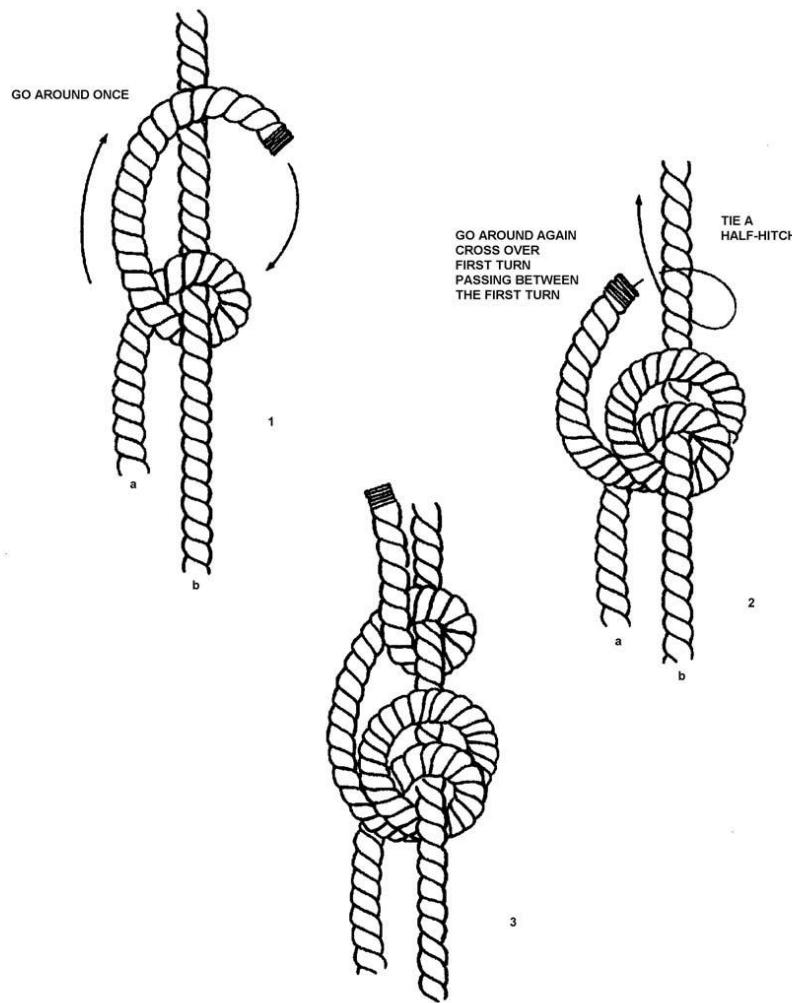


**Figure 7-14**  
**Two Half Hitches**

#### D.5.d. Rolling Hitch (Stopper)

A rolling hitch is used to attaché one line to another, where the second line is under a strain and cannot be bent. Refer to **Figure 7-15** while performing the following procedures:

| Step | Procedure  |
|------|--|
| 1    | With the bitter end "a", make a turn over and under the second line "b" and pass the link over itself      |
| 2    | Pass "a" over and under "b" again bringing "a" through the space between the two lines on the first turn.  |
| 3    | Pull taut and make another turn with the bitter end "a" taking it over, then under, then back over itself. |
| 4    | Pull taut and tie a half hitch.  |

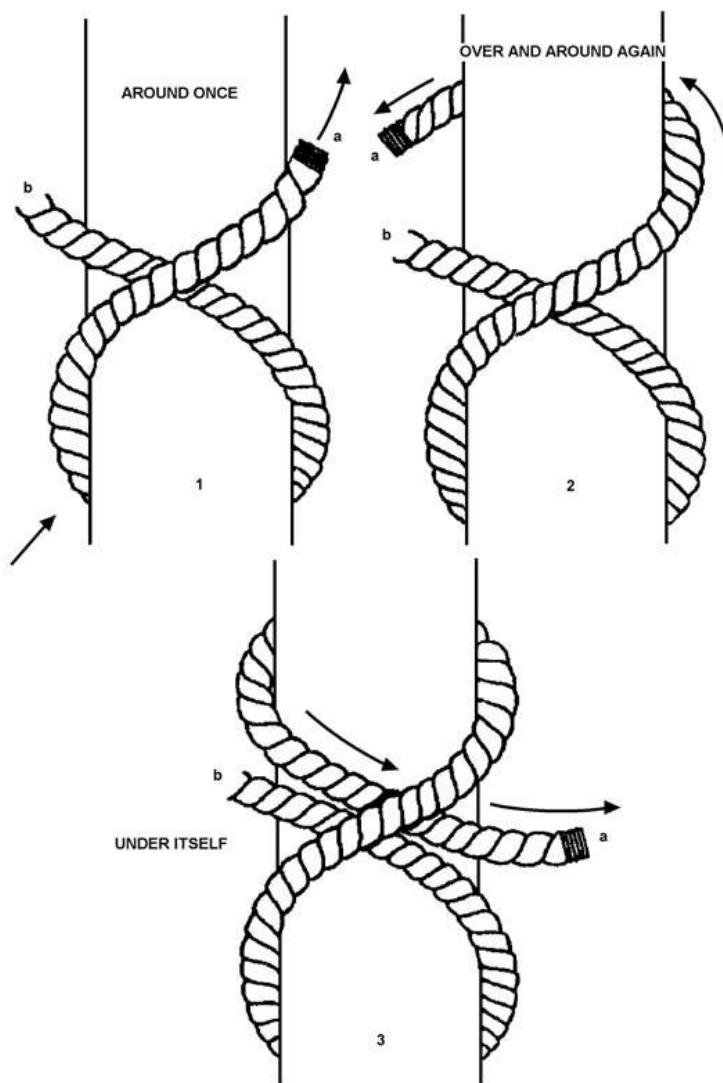


**Figure 7-15**  
**Rolling Hitch**

#### D.5.e. Clove Hitch

A clove hitch is preferred for securing a heaving line to a towline. It is the best all-around knot for securing a line to a ring or spar. Correctly tied, a clove hitch will not jam or loosen. However, if it is not tied tight enough, it may work itself out. Reinforcing it with a half hitch will prevent this from happening. Refer to **Figure 7-16** while performing the following procedures:

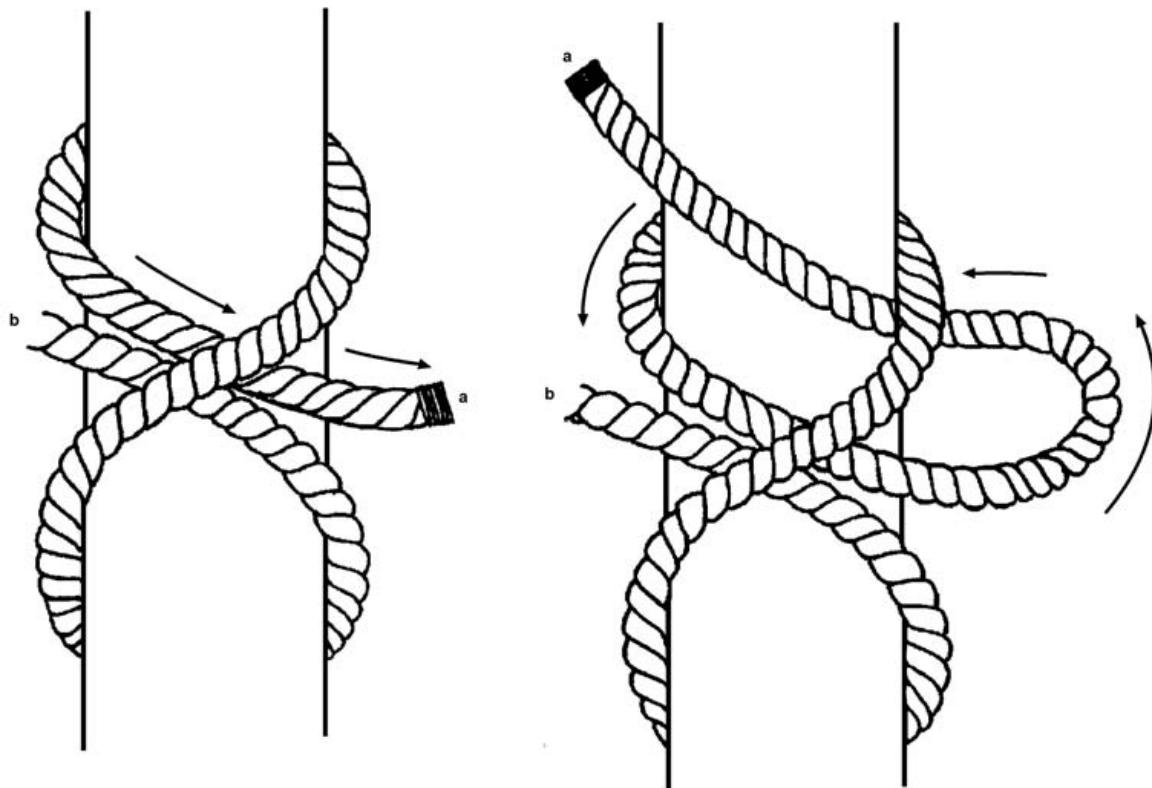
| Step | Procedure  |
|------|--|
| 1    | Pass the bitter end "a" around the object so the first turn crosses the standing part. |
| 2    | Bring the bitter end "a" around again and pass it through itself                       |
| 3    | Pull taut.   |
| 4    | Reinforce by tying a half hitch.   |



**Figure 7-16**  
**Clove Hitch**

#### D.5.f. Slip Clove Hitch

A slip clove hitch should be used in lieu of a clove hitch when a quick release is required. It should be tied in the same manner as the clove hitch but finish it with a bight to allow for quick release. (See **Figure 7-17**) It is sometimes used for stowing lines and fenders. It should not be used when working with the line.

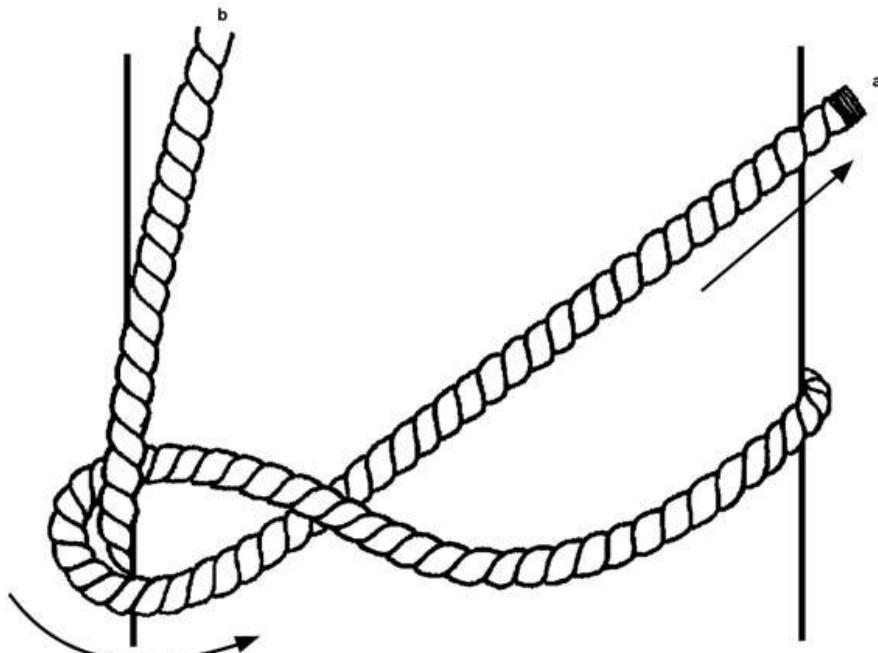


**Figure 7-17**  
**Slip Clove Hitch**

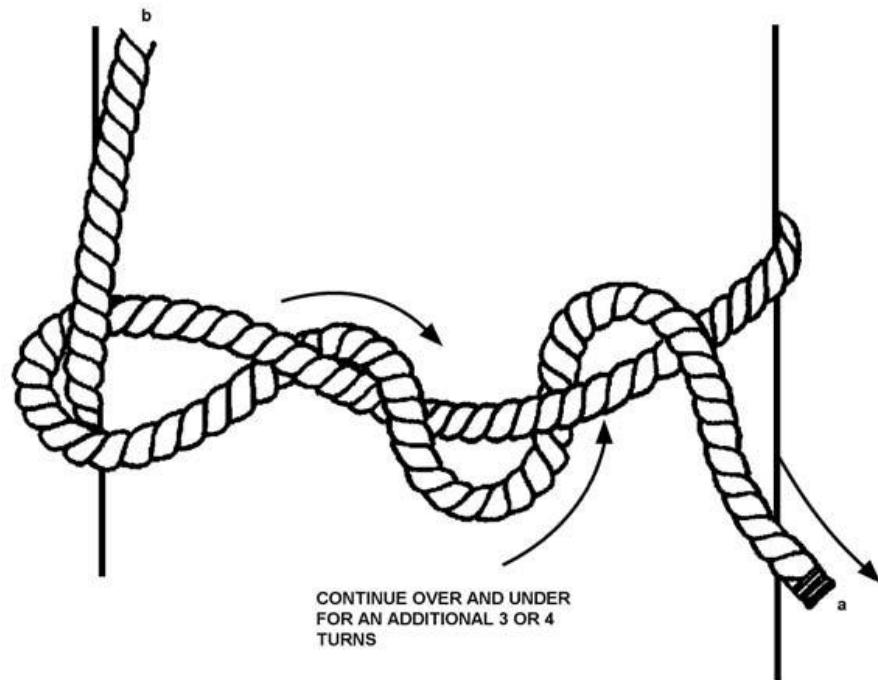
#### D.5.g. Timber Hitch

Timber hitches are used to secure a line to logs, spars, planks, or other rough-surfaced material, but should not be used on pipes or other metal objects. Refer to **Figure 7-18** while performing the following procedures.

| Step | Procedure  |
|------|--|
| 1    | Tie a half hitch   |
| 2    | Continue taking the bitter end "a" over and under the standing part.   |
| 3    | Pull the standing part taut.   |
| 4    | Add two half hitches for extra holding if necessary. (See <b>Figure 7-19</b> ) Unless the half hitch can be slipped over the end of the object, tie it before making the timber hitch. |



TIE A HALF HITCH



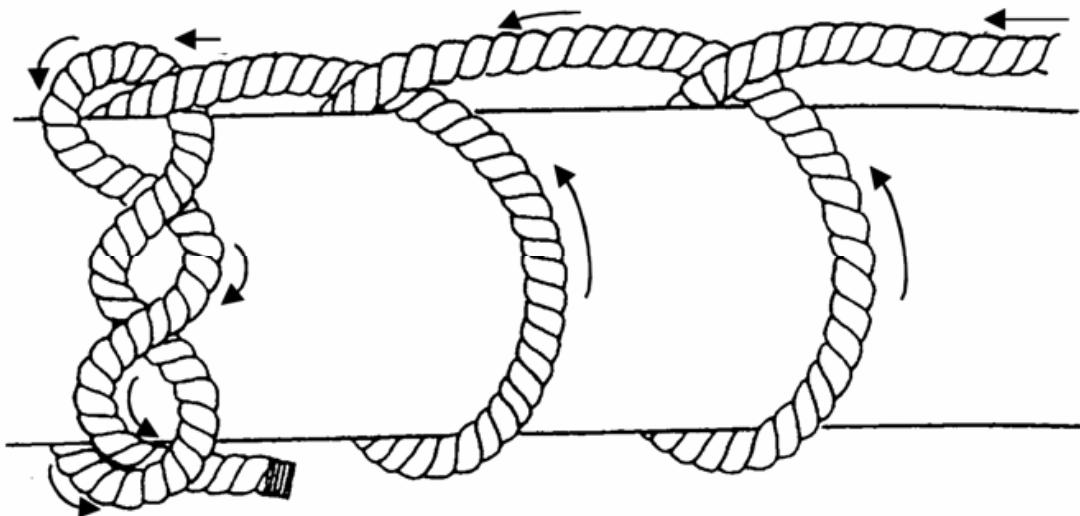
CONTINUE OVER AND UNDER  
FOR AN ADDITIONAL 3 OR 4  
TURNS

Figure 7-18  
Timber Hitch

TIE A TIMBER HITCH

AROUND THE OBJECT  
TIE A HALF HITCH

AROUND - TIE  
ANOTHER HALF  
HITCH



**Figure 7-19**  
**Timber Hitch with Two Half Hitches**

**D.5.h. Single Becket Bend (Sheet Bend)**

Lines can be lengthened by bending one to another using a becket bend. It is the best knot for connecting a line to an eye splice in another line. It can be readily taken apart even after being under a load. Single becket bends are used to join line of the same size or nearly the same size. It is intended to be temporary. Refer to **Figure 7-20** while performing the following procedures.

| Step | Procedure   |
|------|---|
| 1    | Form a bight in one of the lines to be joined together, line "a".                             |
| 2    | Pass the bitter end of the second line "b" up through the bight formed by the first line "a". |
| 3    | Wrap the end of line "b" around the bight in "a".   |
| 4    | Pass the end of "b" under its own standing part.  |
| 5    | Pull taut.  |

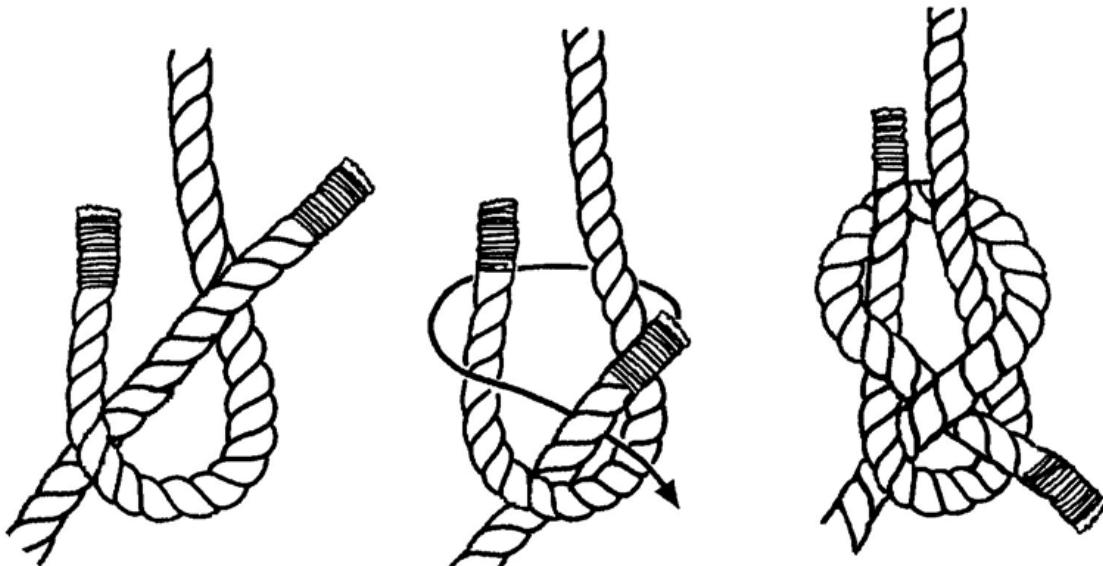


Figure 7-20  
Single Becket Bend/Sheet Bend

**D.4.i. Double Becket Bend (Double Sheet Bend)**

The double becket bend works for joining lines of unequal size. It is tied in the same manner as the single becket bend except for the following variation in step 4 above: Pas line "b" around and under its standing part twice. (See **Figure 7-21**)

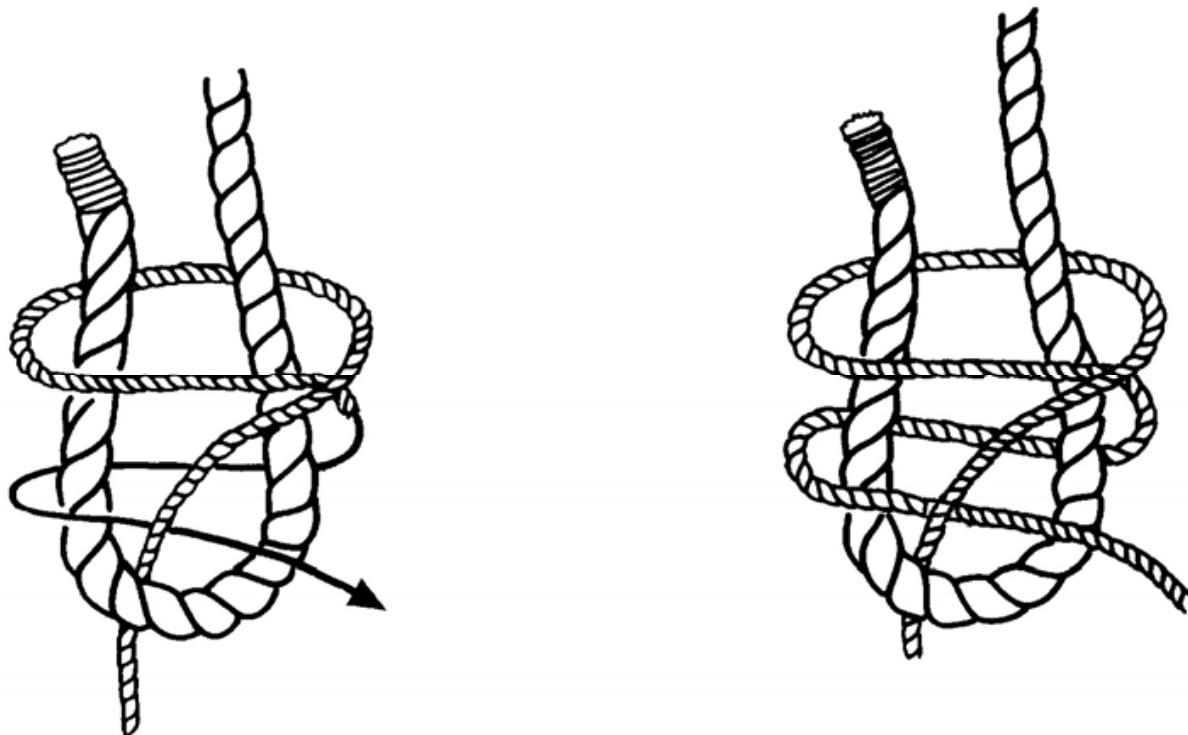
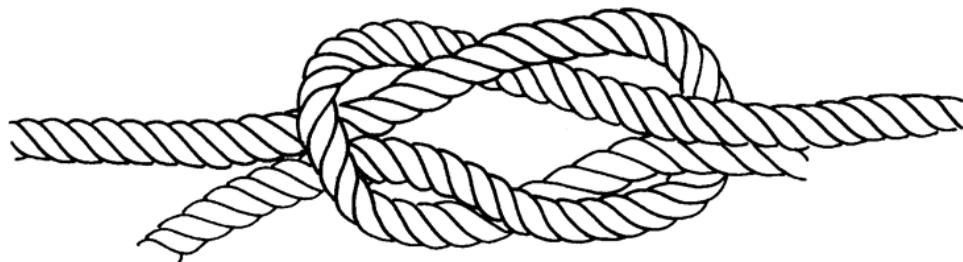


Figure 7-21  
Double Becket Bend/Sheet Bend

#### D5.j. Reef Knot (Square Knot)

Called a square knot by Boy Scouts, the reef knot is one of the most commonly used knots in marlinspike seamanship. Reef knots are primarily used to join two lines of equal size and similar material. Caution should be used if the line is going to be under heavy strain since the reef knot can jam badly and become difficult to untie afterwards. Reef knots are best used to finish securing laces (canvas cover, awnings, sail to a gaff, etc.), temporarily whippings, and other small stuff. Refer to **Figure 7-22** while performing the following procedures:

| Step | Procedure  |
|------|--|
| 1    | Tie a single overhand knot   |
| 2    | Tie a second overhand knot on top so it mirrors (right and left reversed) the first one. The ends should come together |
| 3    | Draw tight.  |

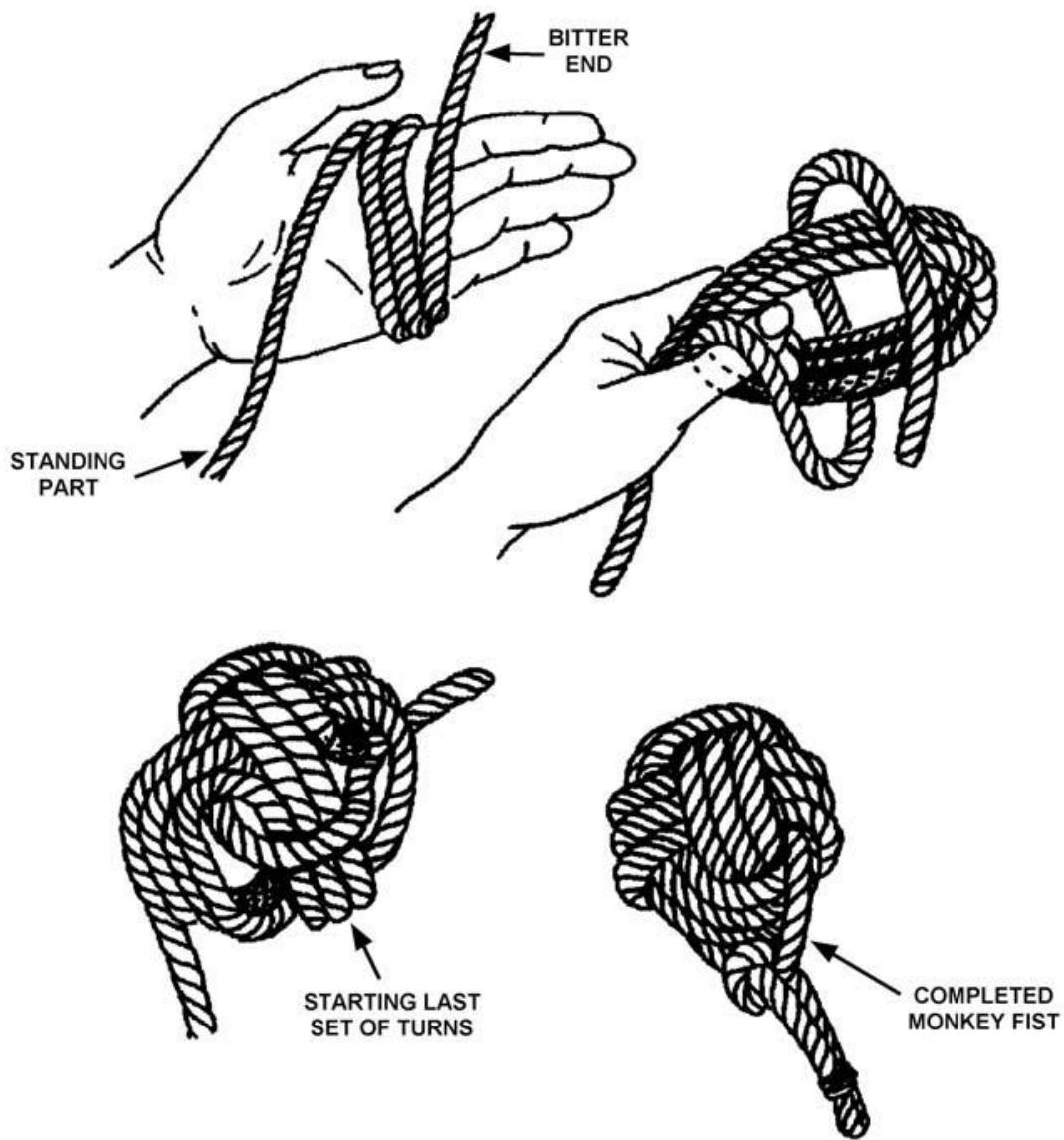


**Figure 7-22**  
**Reef Knot (Square Knot)**

#### D.5.k. The Monkey's Fist

Because some lines, such as towlines, are too heavy and awkward to throw any distance, a smaller line called a "heaving line" which is weighted at one end is used to pass the towline to a disabled vessel. Most heaving lines today are between 75 and 100 feet long and use a softball sized rubber ball at the end to provide the additional weight needed during the throw. Another option would be to tie a monkey's fist at one end of the heaving line. Placing pieces of metal (lead or steel), as additional weight in the monkey's fist, will not be used since it could cause damage to personnel or property upon impact. Scrap pieces of line, leather, or cloth can be used instead to provide additional weight needed to throw the heaving line. Refer to **Figure 7-23** while performing the following procedures:

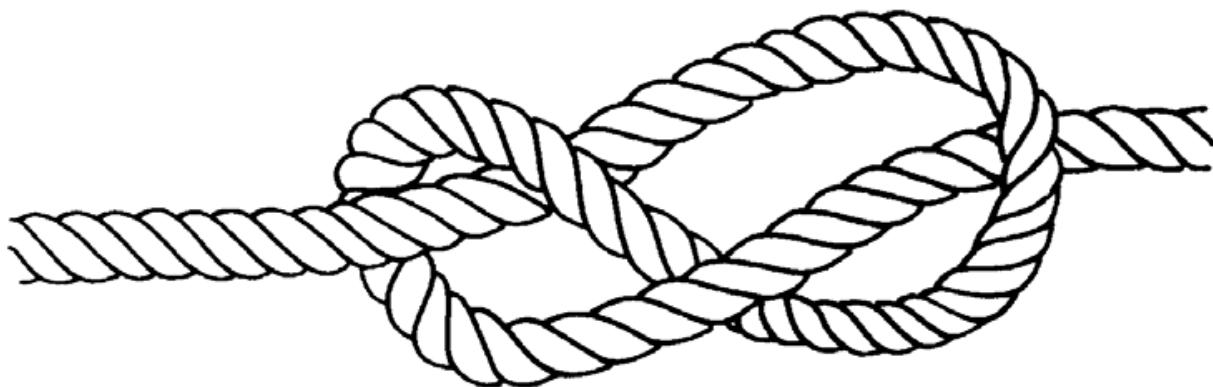
| Step | Procedure   |
|------|---|
| 1    | Lay a bight of the line across the fingers of the left hand, about three and one-half feet from the end, holding the standing part with the left thumb. |
| 2    | With fingers separated, take three turns around them.   |
| 3    | Next take three turns around the first three and at right angles to them.   |
| 4    | Take the knot off fingers and take an additional three turns around the second three, and inside the first three  |
| 5    | Take additional care at this step. Place the core weight (pieces of line, leather, or cloth) into the knot and tighten it down carefully.               |
| 6    | After tightening, there should be about 18 inches of line left on the bitter end. This can be brought up and seized alongside to the standing part.     |



**Figure 7-23**  
**Monkey's Fist**

**D.5.I. Figure Eight (Stopper)**

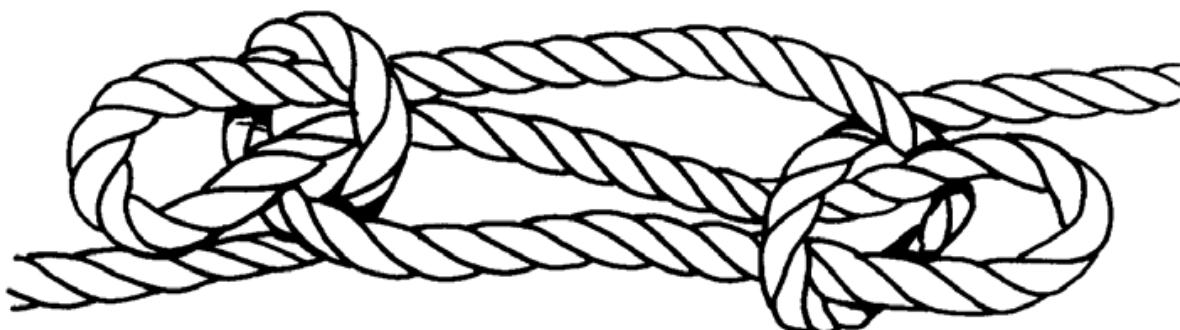
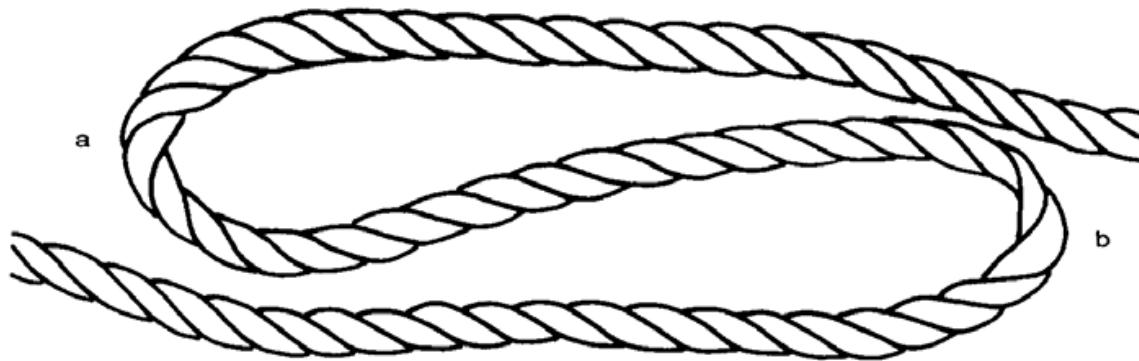
A figure eight knot is an overhand knot with an extra twist. It will prevent the end of a line from feeding through a block or fairlead when loads are involved. It is also easier to untie and does not jam as hard as the over hand knot (See **Figure 7-24**)



**Figure 7-24**  
**Figure Eight Knot**

**D.5.m. Sheepshank**

The sheepshank hitch is used for temporary shortening a piece of line. It consists of two bights of line, side-by-side, with a half hitch at either end. (See **Figure 7-25**)

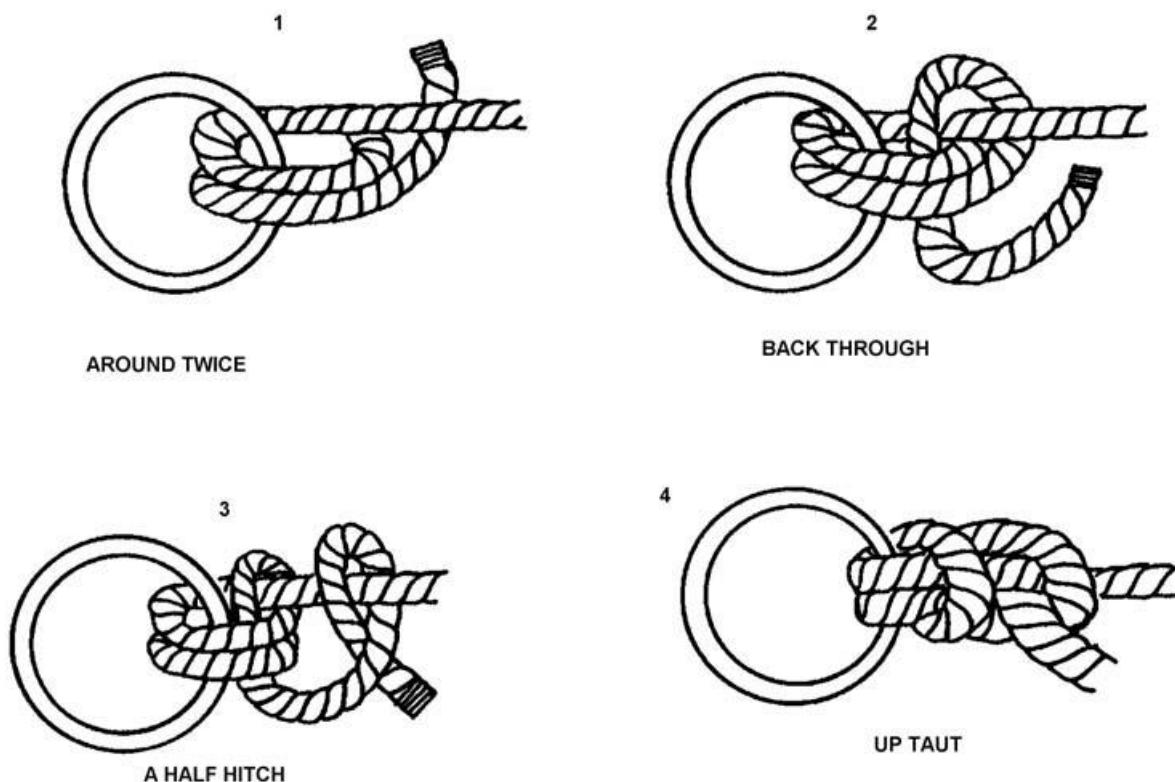


**Figure 7-25**  
**Sheepshank**

#### D.5.n. Fisherman's or Anchor Bend

The fisherman's, or anchor bend is used to secure a line to a ring in an anchor or mooring buoy. It can also be tied around a spar. Refer to **Figure 7-26** while performing the following procedures:

| Step | Procedure  |
|------|--|
| 1    | Pass the bitter end through the ring and around twice creating two loops spiraling downward. |
| 2    | Wrap the bitter end up around the standing end and pass back through the loops at the top.   |
| 3    | Tie a half hitch.  |
| 4    | Pull taut.   |



**Figure 7-26**  
**Fisherman's or Anchor Bend**

#### D.5.o. Crown Knot

A crown knot may be used to prevent an unwhipped line from unlayment. Refer to **Figure 7-27** while performing the following procedures:

| Step | Procedure  |
|------|--|
| 1    | Unlay the strands of the line about 12".                         |
| 2    | Separate the strands and hold them up, facing the middle strand. |
| 3    | Bend the middle strand "a" away and form a loop.                 |

|   |  |
|---|--|
| 4 | Bring the right strand "b" around behind the loop, placing it between strands "a" and "c".                   |
| 5 | Bring strand "c" over strand "b" and through the loop formed by strands "a".                                 |
| 6 | Pull taut by heaving on each of the three strands.   |
| 7 | Lay the back splice by tucking each strand backup the line. The splicing is done as if making an eye splice. |

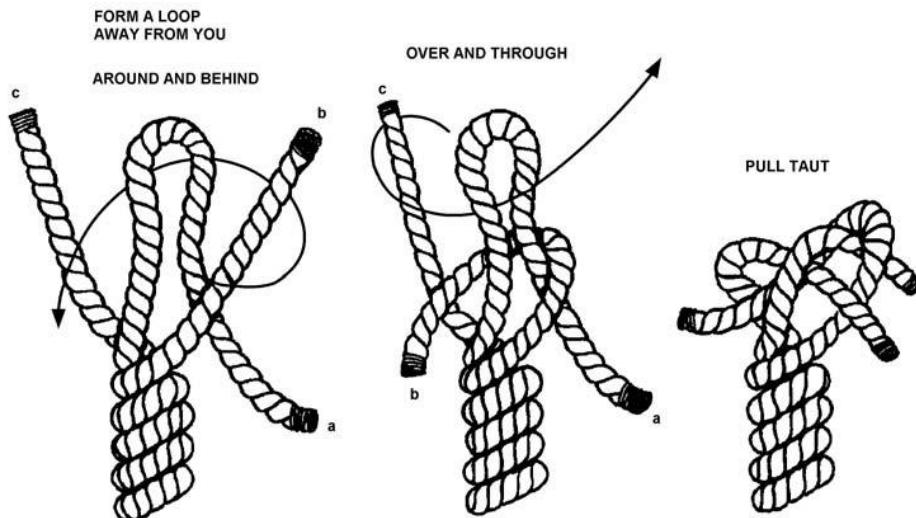


Figure 7-27  
Crown Knot

## Splices

### D.6. Procedure

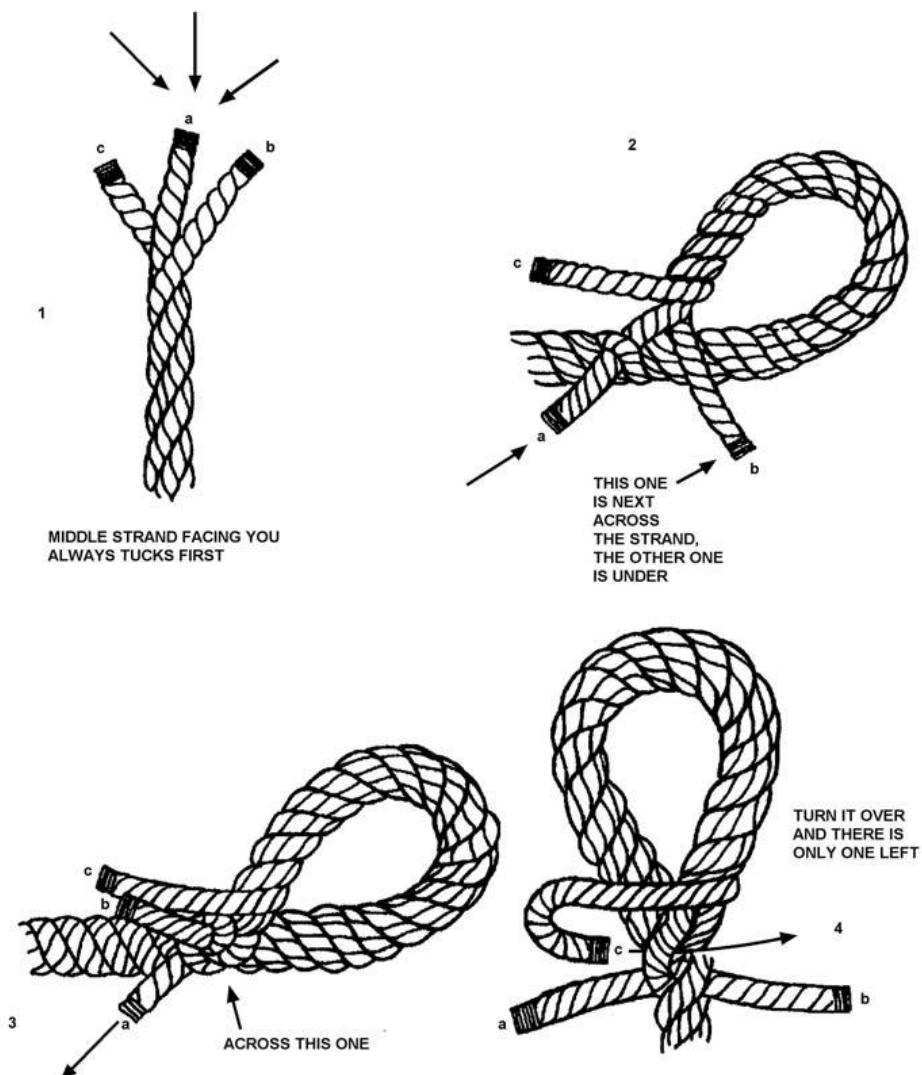
Splices form a more permanent joining of two lines or two parts of a line. Splicing can be done with many different styles of line including three-strand and double-braided. Three-strand lines are unlaid and woven back into themselves or into another line. Double-braided lines go through a series of core/cover removals and tucks in order to complete the splice. Splices are preferred over knots since they allow the line to retain more of its original working strength. The type of splice used depends on the type of joint and the type of line. On Division vessels, the most common splices are eye splices at the working end of the towline, side lines, and mooring lines. Eye, back, and short splices will be illustrated for plain laid three-strand line and eye and short 9end-for-end) splices will be illustrated for double-braided nylon.

### D.7. Eye Splice in Three-Strand Plain-Laid Line

The eye splice makes a permanent loop (the eye) in the end of a line. Refer to Figure 7-28 while performing the following procedures:

| Step | Procedure                                |
|------|--|
| 1    | Unlay the strands of the line about 12". |

|      |   |
|------|---|
| 2    | Make a bight the size of the eye required.  |
| 3    | Hold the strands up so the middle strand is facing you.   |
| 4    | Tuck the middle strand "a".   |
| NOTE | Always tuck the middle strand first, and keep the right-hand strand of the side of the line that is facing toward you. All tucks are made from outboard toward the person tying.  |
| 5    | Cross-strand "b" over the strand just tucked and then under the strand just below it.   |
| 6    | Turn the entire eye splice over and tuck strand "c".  |
| 7    | Pull all strands tight.   |
| 8    | Pass each strand over the adjacent strand and under the next strand (over & under). The number of tucks depends on the material of the line being worked with. Natural fiber lines should be tucked a minimum of three times. Synthetic fiber lines require four or more tucks each to ensure they do not slip. |

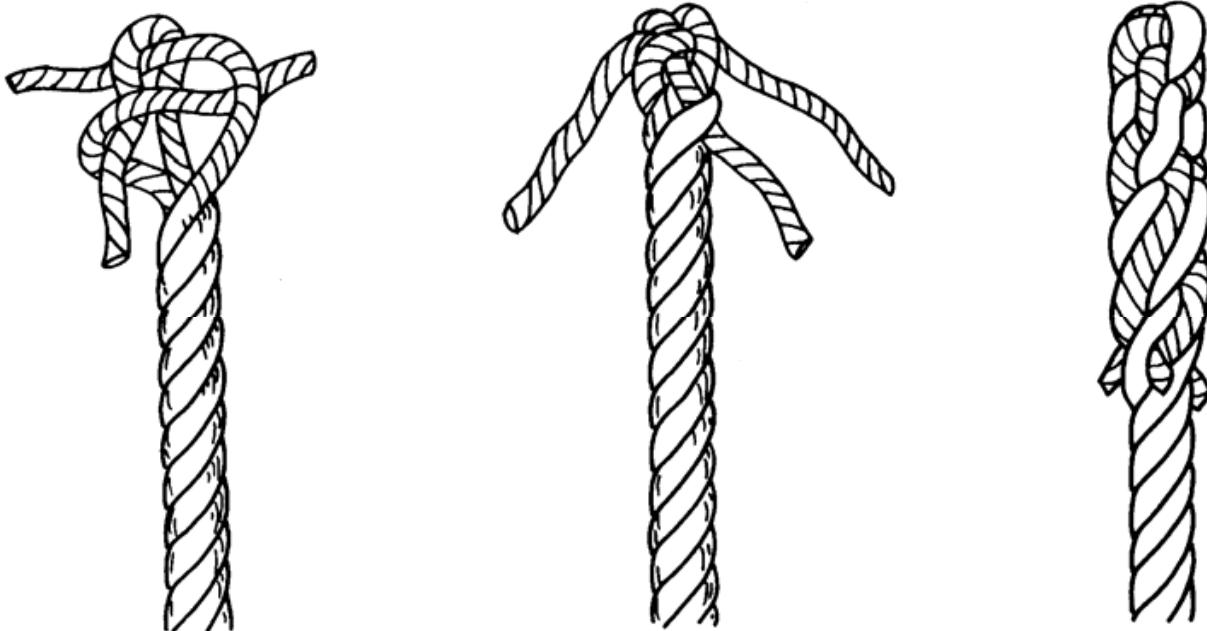


**Figure 7-28**  
**Three-Stranded Eye Splice**

#### D.8. Back Splice in Three-Strand Plain-Laid Line

A back splice is commonly used to finish off the end of a line. On Division vessels, it can be used on the ends of fender lines. Care should be used when selecting a back splice to finish off a line. The splice will increase the diameter of the line that may cause it to jam or foul when running through a block or deck fitting. If the line must be able to run free, a permanent whipping (see **Figure 7-32**) on the end is preferred to prevent unraveling. Crewmembers should start with unlacing the strands at the end, then bending them back on the line, and then interweaving them back through the strands of the standing part. Refer to **Figure 7-29** while performing the following procedures:

| Step | Procedure  |
|------|--|
| 1    | Begin the back splice by tying a crown knot (See <b>Figure 7-29</b> ). Each strand goes under and out from its neighbor in the direction of the lay. |
| 2    | Pass each strand under itself, just beneath the crown knot. Do not pull these first tucks too tight.   |
| 3    | Proceed with three more rounds of tucks – over one, under one, and in an eye splice.   |
| 4    | If preferred, it can be finished by trimming the ends of the strands.  |



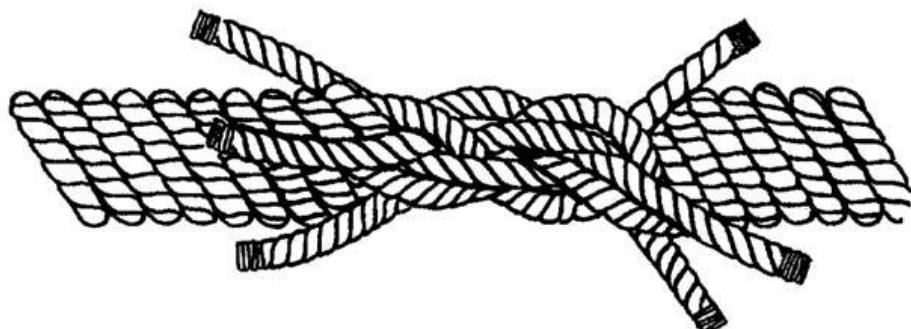
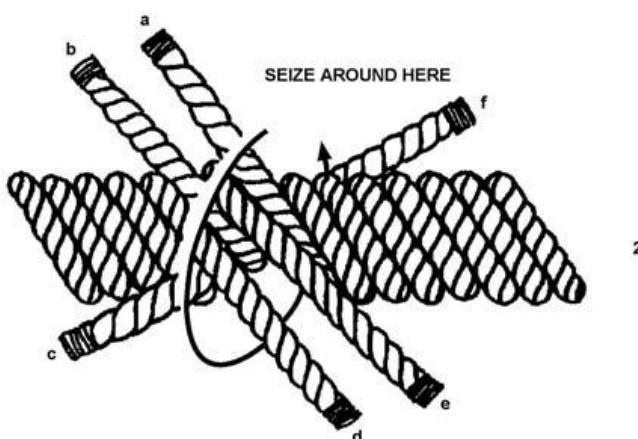
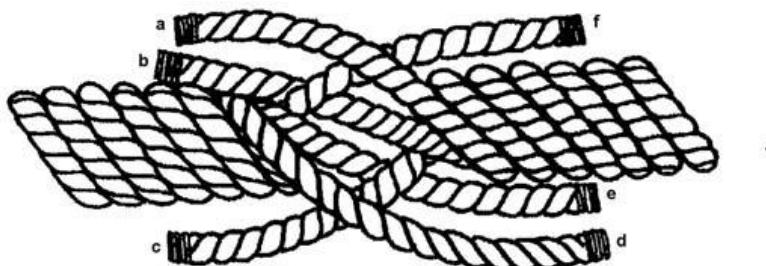
**Figure 7-29**  
**Back Splice (Three-Strand)**

#### D.9. Short Splice

A short splice is used to permanently connect two ends of a line. It is important to note that a short splice is never used in a line that must pass over a pulley or sheave. Refer to **Figure 7-30** while performing the following procedures:

| Step | Procedure  |
|------|--|
| 1    | Unlay the strands of the lines to be spliced, about 12". |
| 2    | Bring the ends together by alternating strands.          |

|   |   |
|---|---|
| 3 | Slide the two ends together, that is, butt them and temporarily seize them with sail twine or tape.                         |
| 4 | Tuck each strand over and under three times, the same way as in eye splicing. (Synthetic line requires an additional tuck.) |
| 5 | Remove the seize.   |



**Figure 7-30**  
**Sport Splice**

#### **D.10. Eye Splice in Double-Braided Line**

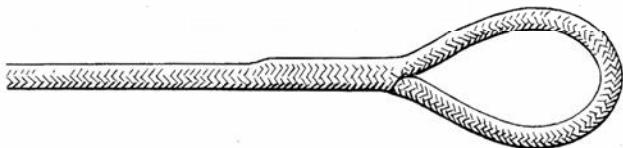
Splicing a double-braided line entails pulling the core out of the cover and then putting the line back together to make the splice. The basic principle for putting it back together is:

- The cover goes into the core.
- Then the core goes back into the cover.

Splicing a double-braided line requires the use of special equipment. The “pusher” and “fid” are especially designed to splice a certain size of line. The correct measurements supplied by the manufacturer must be used before starting the splice. One mistake in a measurement can result in an improper and dangerous splice. Utilize the following instructions for splicing a double-braided line:

NOTE: The following series of steps (which is under copyright by Sampson Ocean Systems, Inc.). Other manufacturers of double-braided line provide splicing instructions. Specific information for splicing should be requested from the appropriate manufacturer.

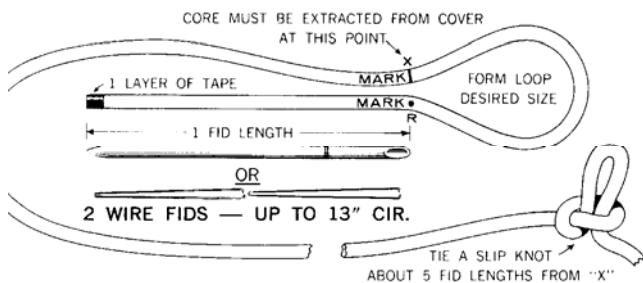
## Standard Eye — NEW ROPE



This Samson Eye Splice is for new rope only. It retains approximately 90% of the average new rope strength.

For splicing used rope, start with Step 1B, on Page 29.

### MARKING THE MEASUREMENTS . . . STEP 1A



On rope over 1" diameter, it is often easier to pass a spike or similar object through the rope instead of tying a slipknot.

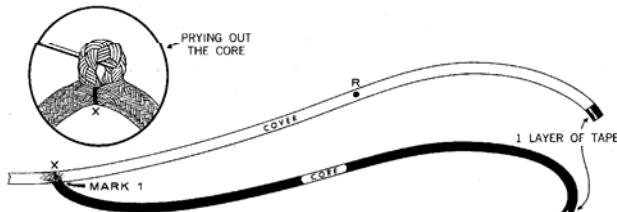
Tape end to be spliced with one thin layer of tape. Then, measure one tubular fid length (2 wire fid lengths because wire fid is  $\frac{1}{2}$  size) from end of rope and mark. This is Point R (Reference).

From R form a loop the size of the eye desired and mark. This is Point X where you extract core from inside the cover. If using a thimble, form the loop around the thimble. (See Special Tips, for more information on installing a thimble).

Tie a tight slip knot approximately five fid lengths from X.  
**THIS MUST BE DONE.**

In the event you require the rope with the finished splice(s) to be a certain overall length, refer to Special Tips.

### STEP 2A . . . NEW ROPE: EXTRACTING THE CORE



Bend rope sharply at X. With the pusher or any sharp tool such as an ice pick, awl, or marlin spike, spread the cover strands to expose core. First pry, then, pull the core completely out of cover from X to the taped end of the rope. Put one layer only of tape on end of core.

**Note:** DO NOT pull cover strands away from rope when spreading cover as this will distort rope unnecessarily.

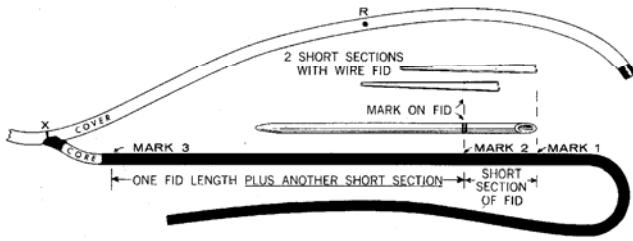
To assure correct positioning of Mark #1 do the following.

Holding the exposed core, slide cover as far back towards the tightly tied slipknot as you can. Then, firmly smooth the cover back from the slip knot towards taped end. Smooth again until all cover slack is removed.

Then, mark the core where it comes out of the cover.

**THIS IS MARK #1.**

## NEW ROPE: MARKING THE CORE . . . STEP 3A



Again slide cover toward slipknot to expose more core.

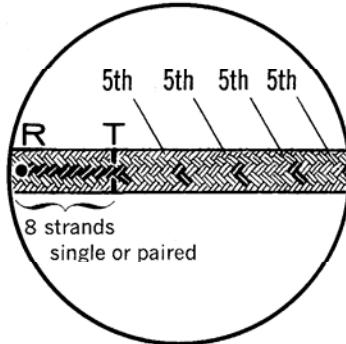
From Mark #1, measure along core towards X a distance equal to the short section of tubular fid (2 short sections with wire fid) and make two heavy marks.

**THIS IS MARK #2.**

From Mark #2 measure in the same direction one fid length plus another short section of the fid. (With wire fid, double measurements) make 3 heavy marks.

**THIS IS MARK #3.**

## STEP 4A . . . NEW ROPE: MARKING THE COVER FOR TAPERING

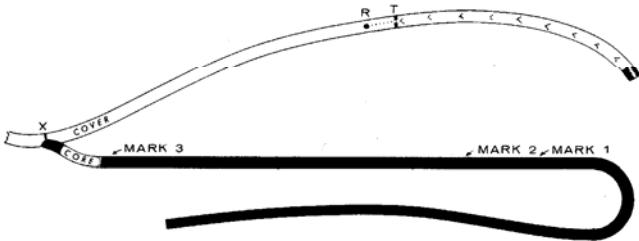


Note nature of cover braid. It is made up of strands — either one or two (pair). By inspection you can see half the strands revolve to the right around rope and half revolve to the left.

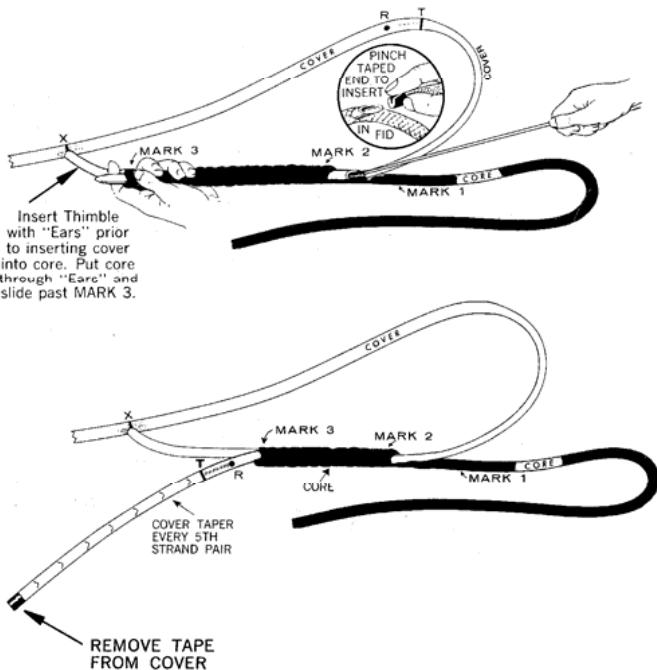
Beginning at "R" and working toward tapered end of the cover, count 8 consecutive strands (single or pairs) which revolve to the right (or left). **MARK THE 8th STRAND.**

This is Point T. (See Insert). Make Mark T go completely around cover.

Starting at T and working toward the tapered cover end, count and mark every fifth right and left strand (single or paired) until you have progressed down to end of tapered cover.



## NEW ROPE: PUTTING THE COVER INSIDE CORE . . . STEP 5A



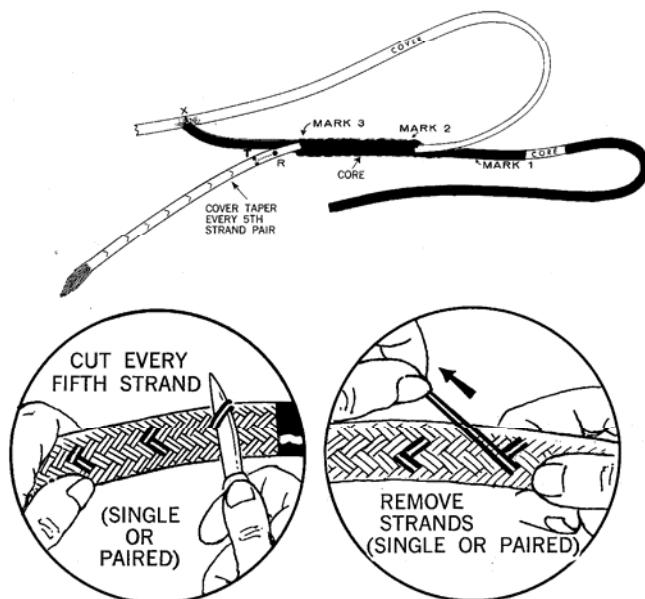
Insert fid into core at Mark #2. Slide it through and out at Mark #3.

Add extra tape to cover end; then jam it tightly into the hollow end of fid (See Insert). Hold core lightly at Mark #3, place pusher joint into tapered end, and push fid and cover through from Mark #2 and out at Mark #3.

With wire fid first press prongs into cover, then tape over (see "Tools Needed"). Then after fid is on, milk braid over fid while pulling fid through from Mark #2 to Mark #3.

Take the fid off the cover. Continue pulling cover tail through the core until Mark R on the cover emerges from Mark #3. Then remove tape from end of cover.

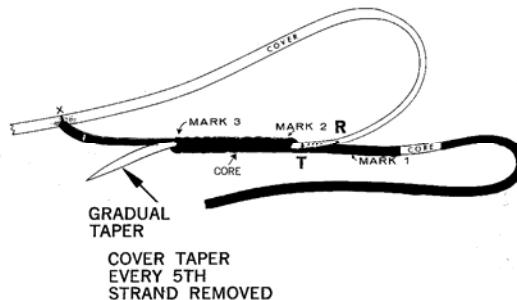
## STEP 6A . . . NEW ROPE: PERFORMING THE TAPER



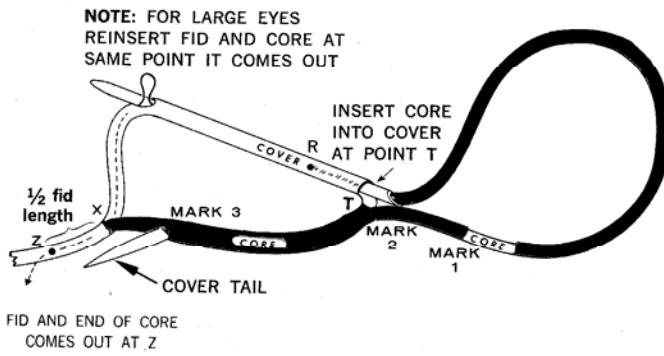
Make sure tape is removed from cover end. Start with last marked pair of cover strands toward the end, cut and pull them completely out (See Insert). Cut and remove next marked strands and continue with each right and left marked strands until you reach Point T. (Do not cut beyond this point. (See Insert).

The result should be a gradual taper ending in a point.

**Very carefully** pull cover back through core until point T emerges from Mark 2 of core.



## NEW ROPE: REINSERTING THE CORE INTO COVER . . . STEP 7A



From point X on cover measure approximately  $\frac{1}{2}$  fid length toward slip knot on rope and mark this as point Z.

You are now ready to put core back into cover from T to Z. Insert fid at T, jam the taped core end tightly into end of fid. With pusher, push fid and core through cover "tunnel", past X, to, and through cover at Z.

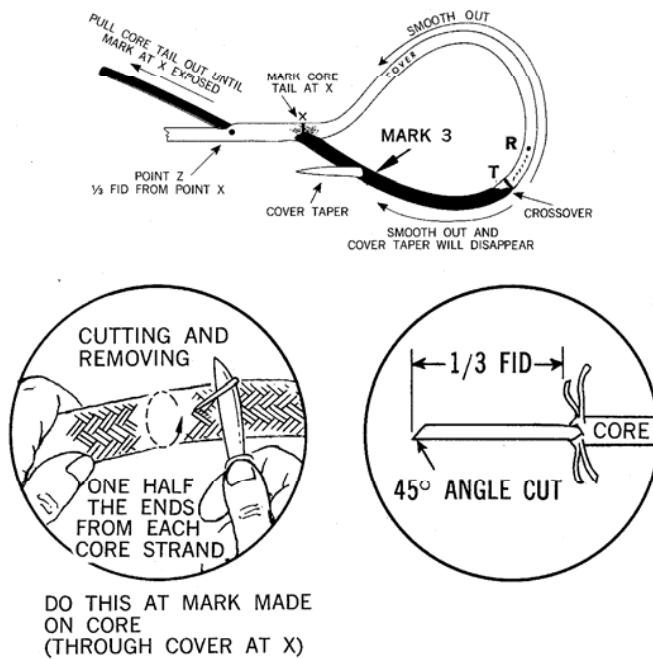
When using wire fid, attach fid to taped core. After fid is on, milk braid over fid while pulling through from T to Z.

When pushing fid past X to Z make sure fid does not catch any internal core strands.

**NOTE:**

Depending on eye size, fid may not be long enough to reach from T to Z in one pass. If not, bring fid out through cover, pull core through and reinsert fid into exact hole it came out of. Do this as many times as needed to reach Z.

## STEP 8A . . . NEW ROPE: MARKING THE REDUCED VOLUME TAIL CORE



Alternately pull on core tail at Z, then pull on tapered cover at MARK 3. The crossover should be tightened until crossover is approximately equal to diameter of rope.

Smooth out cover of eye completely, from crossover (I) toward X, to get all slack out of eye area.

**MARK CORE TAIL THROUGH COVER AT POINT X.**

Pull core tail out until mark on core just made is exposed at Z.

Reduce core volume at this point by cutting and removing one strand at each group, progressing around the circumference of the rope (see insert).

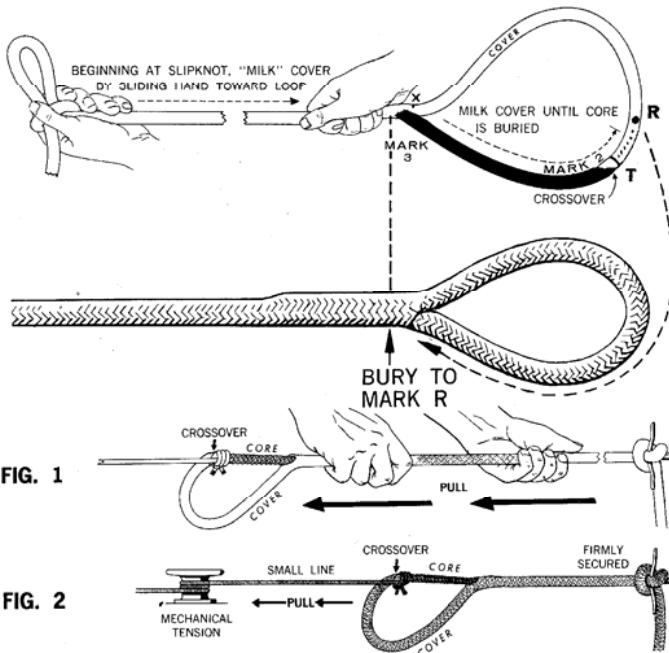
Measure  $\frac{1}{3}$  fid from start of reduction cuts (mark) toward end and mark. Cut off remaining tail at this point. Make cut on a 45° angle to prevent a blunt end (see insert).

With one hand, hold crossover — **MARK T.**

Smooth cover section of eye out firmly and completely from crossover toward X; Reduced volume core tail should disappear into cover at Z.

Smooth out core section from crossover towards MARK 3 and cover taper will disappear into core.

## NEW ROPE: BURYING THE EXPOSED CORE . . . STEP 9A



Hold rope at slipknot and with other hand milk cover toward splice, gently at first, then more firmly. Cover will slide over Mark #3, Mark #2, the crossover, and T and R. (It may be necessary to occasionally smooth out eye during milking to prevent reduced volume tail catching in throat of splice).

If bunching occurs at cross-over preventing full burying, smooth cover from T to X. Grasp crossover at T with one hand and then firmly smooth cover slack (female side of eye) with other hand towards throat (X). Repeat as necessary until bunching disappears.

Continue milking until all cover slack between knot and throat of eye has been removed.

**TIP:**

Before burying the cover over the crossover:

A. Anchor loop of slip-knot by tying it to stationary object before starting to bury. You can then use both hands and weight of body to more easily bury cover over core and crossover. (See Fig. 1 & 2).

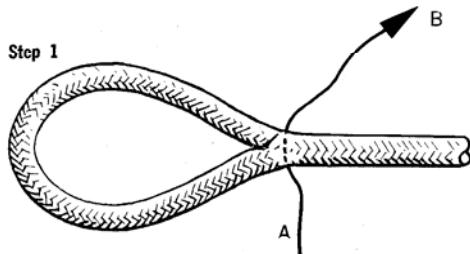
B. Holding the crossover tightly milk all the excess cover from R to X.

Flex and loosen the rope at the crossover point during the final burying process. Hammering cover at point X will help loosen strands.

With larger ropes it is helpful to securely anchor slip-knot, attach a small line to the braided core at the crossover and mechanically apply tension with either a block and tackle, capstan, come-a-long, or power winch. Tension will reduce diameter of core and crossover for easier burying. (See Fig. 2).

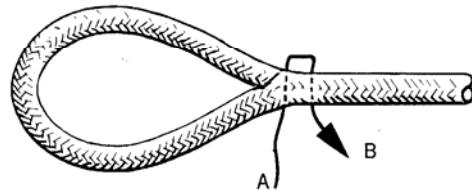
17

## STEP 10A . . . NEW ROPE: FINISHING THE SPLICE WITH LOCK-STITCH



Pass stitching through spliced area near throat of eye as shown.

Step 2



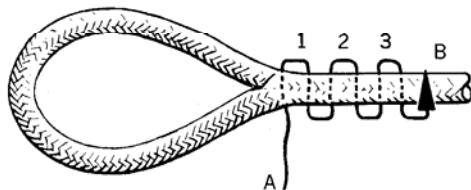
Re-insert as shown pulling snug but not tight.

Stitch locking is advantageous on splices to prevent no-load opening due to mishandling.

Material Required — About one (1) fid length of Nylon or Polyester Whipping Twine approximately the same size of the strands in the size rope you are stitch locking. The same strands cut from the rope you are stitch locking may also be used.

## NEW ROPE: LOCK-STITCH PROCEDURE . . . STEP 11A

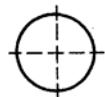
**Step 3**



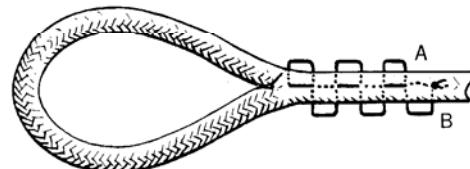
Continue to re-insert as shown until you have at least three (3) complete stitches.

**Step 4**

After completing Step #3, rotate spliced part of rope 90° and re-insert end "A" into splice area in the same fashion as in steps #1, #2, and #3. The splice will now be stitched on two planes perpendicular to each other. Make sure you do not pull stitching too tight.



Configuration of cross section after completing Step #4.



**Step 5**

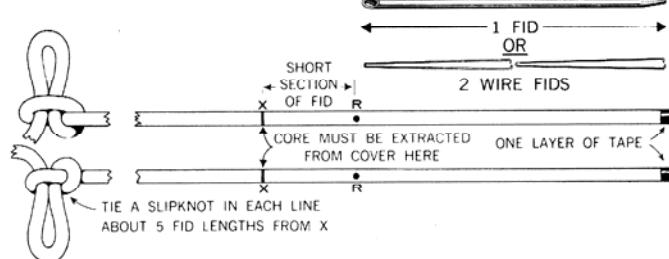
After stitching at least three (3) complete stitches as in step #3, extract two ends A & B together through the same opening in the braid. Tie them together with a square knot and re-insert back into braid between cover and core.

### End-For-End Double Braid



The Samson Standard End-for-End Splice can be performed on new and used rope. This is an all-purpose splice technique designed for people who generally splice used rope as frequently as new rope. It retains up to 85% of average new rope strength and in used rope up to 85% of the remaining used rope strength.

Before splicing used rope, study the Special Tips shown on Page 7.

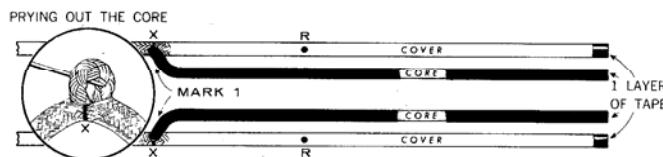


Tape the end of each rope with one thin layer of tape. Lay two ropes to be spliced side by side and measure one tubular fid length (2 wire fid lengths because wire fid is  $\frac{1}{2}$  size) from end of each rope and make a mark. This is Point R (Reference).

From R measure one short fid section length as scribed on the fid; then, mark again. This is Point X where you should extract core from inside cover. Be sure both ropes are identically marked.

Tie a tight slipknot approximately 5 fid lengths from X. If you require the rope with the finished splice to be a certain overall length, refer to Special Tips Page 5.

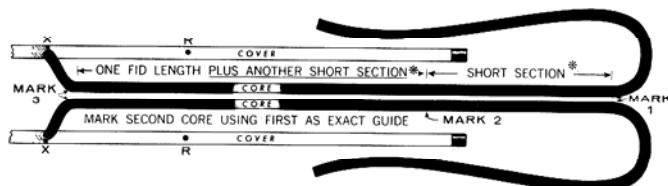
## EXTRACTING THE CORES... STEP 2



**DO NOT PULL COVER STRANDS AWAY FROM ROPE AS THIS WILL DISTORT COVER UNNECESSARILY**

Bend rope sharply at X. With the pusher or any sharp tool such as an ice pick, awl, or marlin spike, spread cover strands to expose core. First pry; then, pull core completely out of cover from X to the end of rope. Put one layer only of tape on end of core.

To assure correct positioning of Mark #1 do the following. Holding the exposed core, slide cover as far back towards the tightly tied slip knot as you can. Then, firmly smooth cover back from the slip knot towards taped end. Smooth again until all cover slack is removed. Then, mark core where it comes out of cover. This is Mark #1. Do this to both ropes.



\*with wire fid double measurements up to 13" cir.

Hold one core at Mark #1 and slide cover back to expose more core.

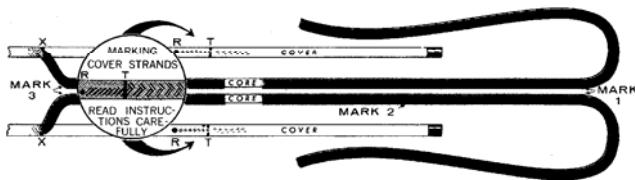
From Mark #1, measure along core towards X a distance equal to the short section of fid \*and make two heavy marks. This is Mark #2.

From Mark #2, measure in the same direction one fid length plus another short section \*and make three heavy marks. This is Mark #3.

Mark second core by laying it alongside the first and using it as an exact guide.

## STEP 4 ... MARKING THE COVER FOR TAPERING

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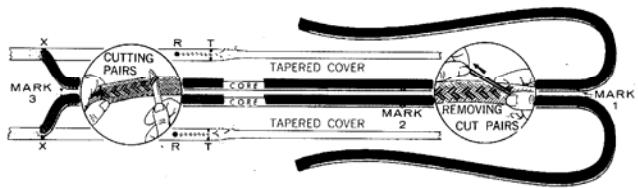
Note nature of the cover braid. It is made up of strands. By inspection you can see that half the strands revolve to the right around the rope and half revolve to the left.

Beginning at R and working toward the taped end of cover, count 8 consecutive pairs of cover strands which revolve to the right (or left). Mark the 8th pair. This is Point T (See Insert). Make Mark T go completely around cover.

Starting at T and working toward taped cover end count and mark every second right pair of strands for a total of 6. Again, starting at T, count and mark every second left pair of strands for a total of 6. (See Insert).

Make both ropes identical.

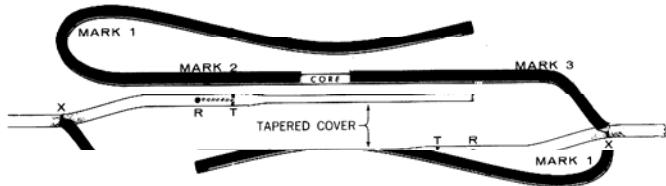
## PERFORMING THE TAPER . . . STEP 5



First remove tape from cover end. Starting with last marked pair of cover strands toward the end, cut and pull them completely out (See Insert). Cut and remove next marked strands and continue with each right and left marked strands until you reach Point T. Do not cut beyond this point. (See Insert)

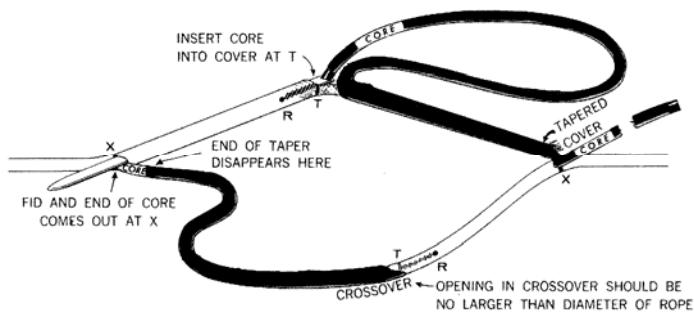
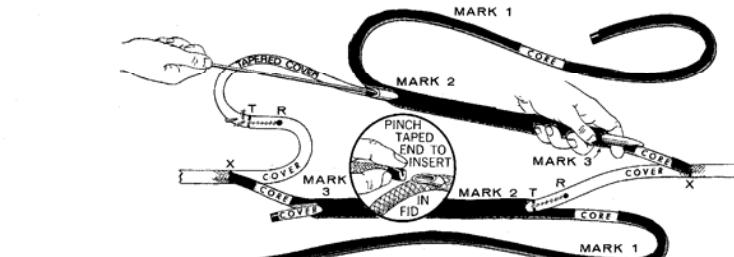
Retape tapered end.

Cut and remove marked strands on the other marked cover, again stopping at T. Retape tapered end.



Reposition ropes for splicing according to diagram. Note how cover of one rope has been paired off with core of the opposite line. **Avoid twisting.**

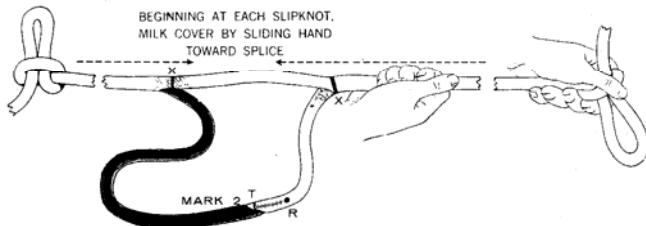
## STEP 7 . . . PUTTING THE COVER INSIDE CORE



Insert fid into one core at Mark #2 and bring it out at Mark #3. Add extra tape to tapered cover end then jam it tightly into hollow end of fid (see insert). Hold core lightly at Mark #3, place pusher point into tapered end pushing fid and with cover in it from Mark #2 out at Mark #3. When using wire fid, attach fid to cover. Then pull fid through from Mark #2 to Mark #3. Pull cover tail through core until Mark T on cover meets Mark #2 on core. Insert other cover into core in same manner.

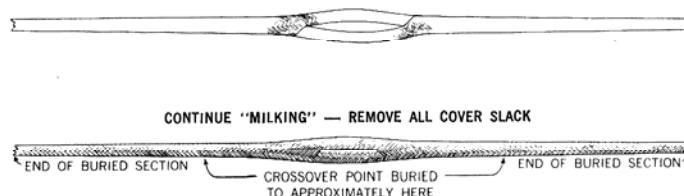
Now put core back into cover from T to X. Insert fid at T, jam taped core tightly into end of fid. With pusher, push fid and core through cover bringing out at Point X. When using wire fid attach fid to tapered core. Then pull fid and braid through from T to X. Do this to both cores. Remove tape from end of cover. Bring crossover up tight by pulling on core tail and on tapered covered tail. Hold crossover tightly smoothing out all excess braid away from crossover in each direction. Trim end of Tapered cover on an angle to eliminate blunt end. Tapered cover tail will disappear at Mark #3. Cut core tail off close to Point X at an angle.

## BURYING THE EXPOSED CORE . . . STEP 9



Hold rope at slipknot and with other hand milk cover toward the splice, gently at first, and then more firmly. The cover will slide over Mark #3, Mark #2 the crossover and R. Repeat with the other side of the splice.

Continue burying until all cover slack between the knot and the splice has been removed.



The splice is done when all cover slack has been removed and there is an opening in the splice approximately equal in length to the diameter of rope. If at the opening one side of the splice is noticeably longer than the other side, something is wrong. Check Steps 1-9 and remake if necessary.

Now untie the slip knots.

## Whipping

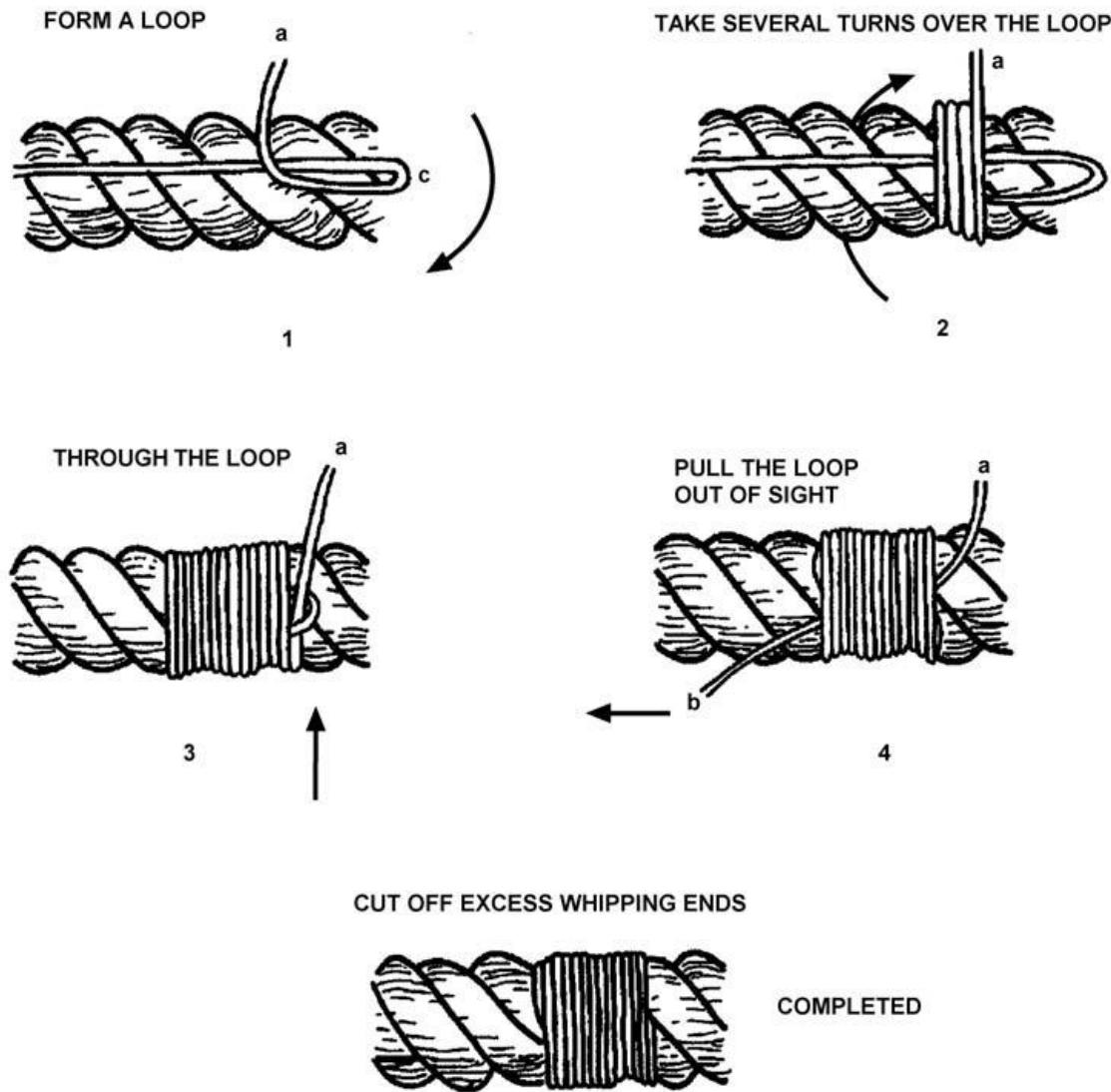
### D.11. Importance

The end of a cut line will unravel and fray if not secured with a whipping or back splice. Whipping may be permanent or temporary.

### D.12. Temporary Whipping

Sometimes called the common whipping, temporary whippings make temporary repairs and secure strands of lines while splicing. They are not very durable and unravel easily if snagged. Whippings are normally made using sail twine, although almost any small stuff will do. Refer to **Figure 7-31** while performing the following procedures:

| Step | Procedure   |
|------|---|
| 1    | Cut a piece of sail twine or small stuff, in lengths about ten times the circumference of the line being seized.  |
| 2    | Lay the sail twine or small stuff alongside the line to be whipped. (See <b>Figure 7-31</b> )   |
| 3    | Form an overhand loop in the sail twine or small stuff such that the loop extends about $\frac{1}{2}$ " beyond the end.   |
| 4    | Holding end "a", make a series of turns over the loop toward the bitter end of the line. Make enough turns so that the length of turns is almost equal to the diameter of the line. |
| 5    | Slip end "a" through the loop "c".  |
| 6    | Secure by pulling loop end from sight by pulling on "b".  |
| 7    | Cut off excess whipping ends or secure them by tying them together with a reef or square knot.  |



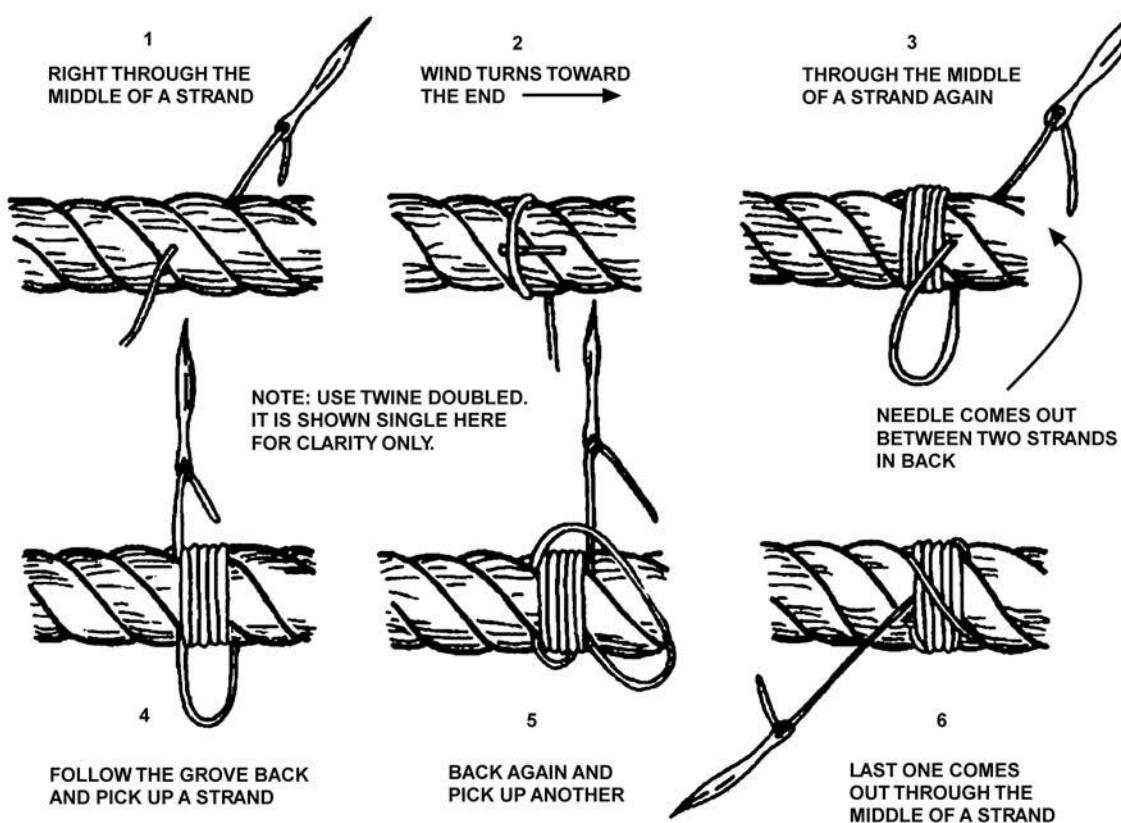
**Figure 7-31**  
**Temporary Whipping**

#### D.13 Permanent Whipping

Permanent whippings are made to last. To make one, several wraps are made around the line using short line or waxed nylon. The ends of the whipping line are then sewn across the whipping and through the line. Refer to **Figure 7-31** while performing the following procedures:

| Step | Procedure   |
|------|---|
| 1    | Cut enough of the whipping line to allow for 15 to 20 wraps, with at least a foot of line left over.            |
| 2    | Secure the whipping line by sewing through the line. If desired, add strength by sewing through more than once. |
| 3    | Wind the whipping line around the line 15 to 20 times, working toward the end of the line.                      |

|   |   |
|---|---|
|   | Make sure the body of the whipping covers the secured end of the whipping line.   |
| 4 | Secure the whipping by sewing through the line. Then bring the line across the whipping and sew it through the line. Do this three or more times, depending on the size of the line.            |
| 5 | Finish the whipping by sewing through the line a couple more times and cutting the whipping line off close. A pull on the line will pull the end of the whipping line inside, hiding from view. |

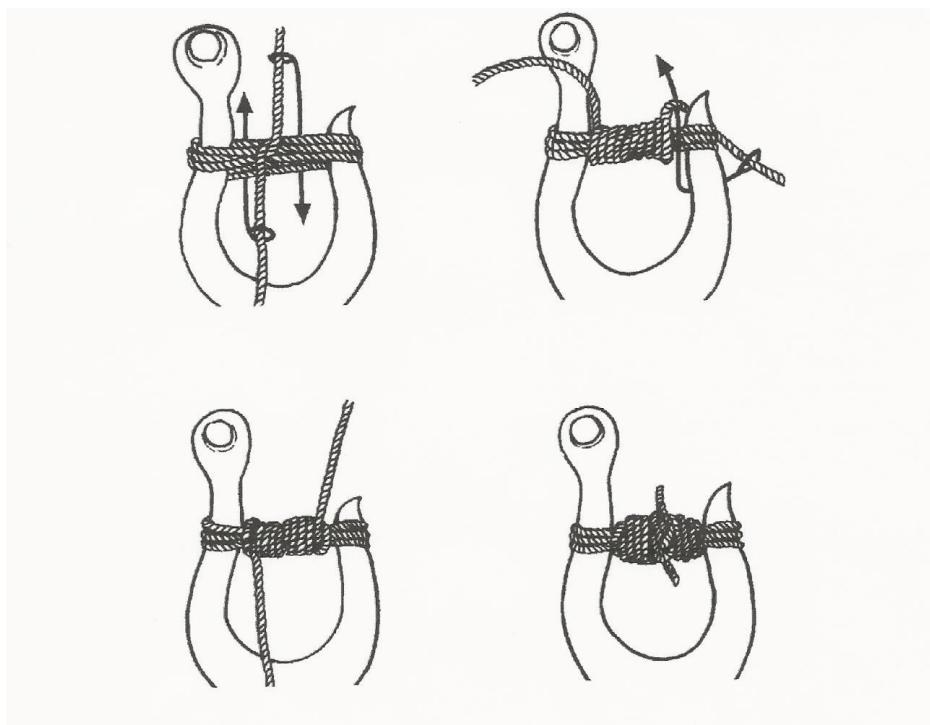


**Figure 7-32**  
**Permanent Whipping**

## Mousing Hooks and Shackles

### D.14. Mousing Hooks

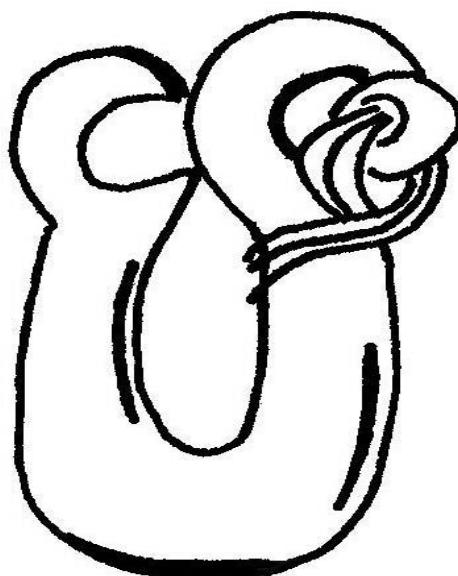
A hook is moused to keep slings and straps from slipping out or off the hooks. This is accomplished by either mechanical means or by seizing the hook, using a seizing wire or small stuff, form opposite sides. (See **Figure 7-33**)



**Figure 7-33**  
**Mousing a Hook**

#### D.15. Shackles

Shackles are moused to prevent the pin from backing out. This is usually done on screw-pin shackles. Mousing is accomplished by taking several turns, using seizing wire or small stuff, through the pin eye and around the shackle itself in such a way so the pin cannot turn. (See **Figure 7-34**)



**Figure 7-34**  
**Mousing a Shackle**

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## Section E. Deck Fittings and Line Handling

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### Introduction

This section explains the procedures for securing lines to the various types of deck fittings.

#### E.1. Deck Fittings

Deck fittings are attachments or securing points for lines. They permit easy handling and reduce wear and friction on lines. There are three basic types of deck fittings:

- Bitts.
- Cleats.
- Chocks.

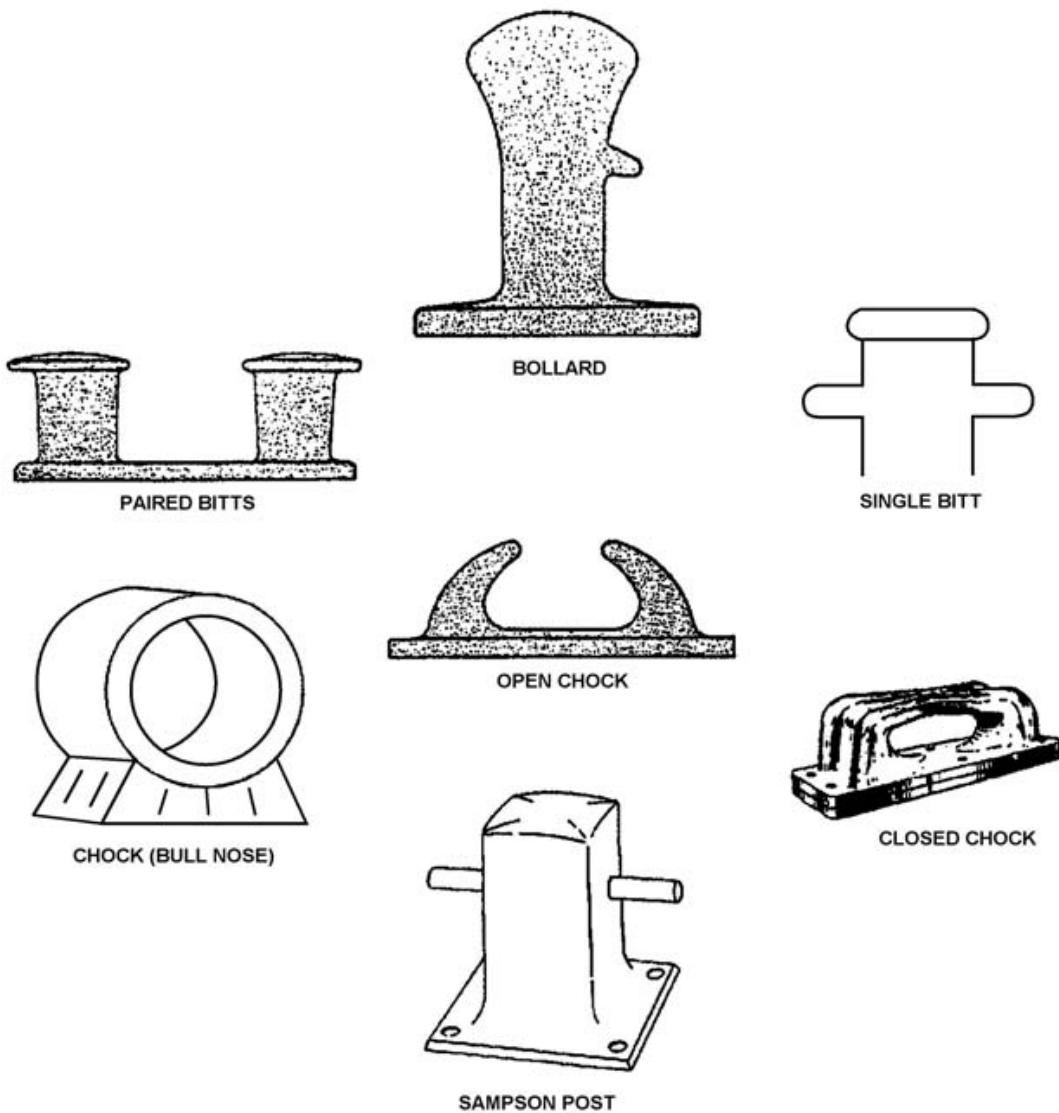


Figure 7-35

## Types of Deck Fittings

### E.2. Line Handling

Division vessels, set up for SAR & Vessel Assist missions, have a towing bitt. Cleats may be found on the decks next to the gunwales on each side of a boat used with bitts and cleats to help prevent chafing of the line. The chock provides a smooth surface for the line to run over or through. Because of the different structural design of nonstandard boats, the strength of their deck fittings will vary widely.

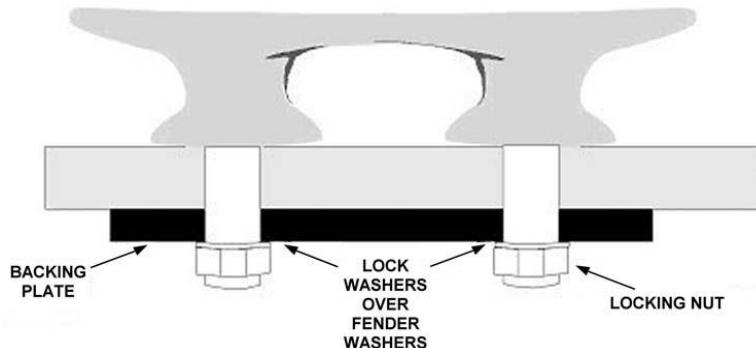
#### E.2.a. Using Properly Sized Line

The size of the deck hardware depends on the size of line to be used for mooring, docking and towing. Cleats are sized by length, and the rule of thumb is the line should be 1/16" diameter for each inch of cleat (3/8" line = 6" cleat, 1/2" line = 8" cleat).

NOTE: On Division vessels (as a rule of thumb) no tow should be attempted with smaller than 3/8" line.

#### E.2.b. Using Backup Plates

All deck hardware that is used for towing should have backup plates to distribute the load over a wide area. (See **Figure 7-36**) The backup plate can be made of pressure treated hardwood or exterior grade plywood, at least twice as thick as the largest bolt diameter. Bolts, not screws should be used. A flat washer and a lock washer must be used with the bolt. The flat washer is three times the bolt diameter. If metal is used, the thickness should be at least the same as the bolt diameter. The use of aluminum is not recommended ([especially at Great Salt Lake where corrosion of mixed metals is a serious problem](#)).



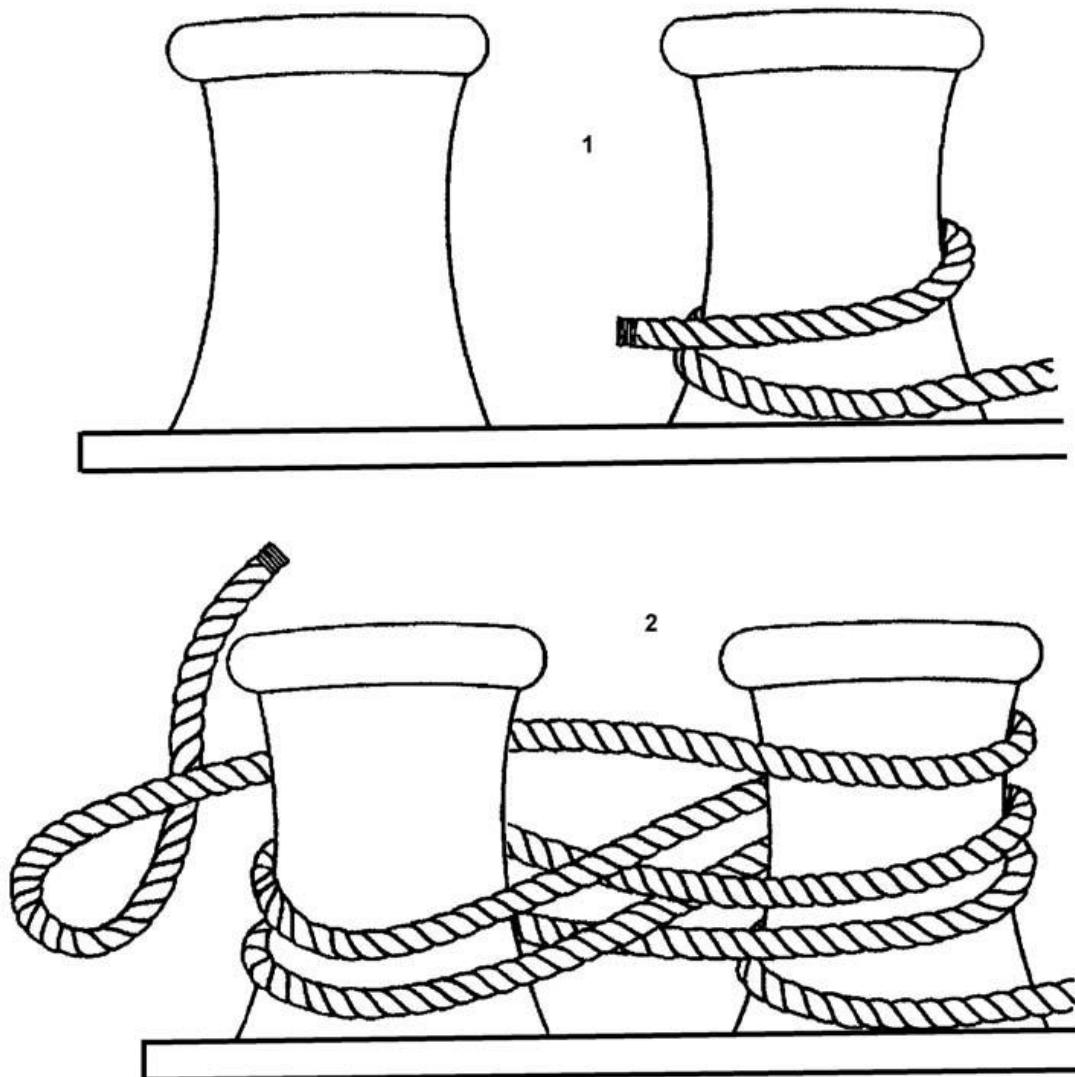
**Figure 7-36**  
**Backup Plate**

#### E.2.c. Securing a Line to a Bitt

The following procedures describe how to secure a line to a set of bitts (See **Figure 7-37**)

| Step | Procedure   |
|------|---|
| 1    | Make a complete turn around the near horn.  |
| 2    | Make several figure eights around both horns. (Size of line and cleats may restrict the number of turns. Minimum of 3 turns is the standard). |
| 3    | Finish off with a round turn  |

NOTE: Avoid the use of half hitches, weather hitches, and lock hitches on standard boats.



**Figure 7-37**  
**Securing a Line to a Bitt**

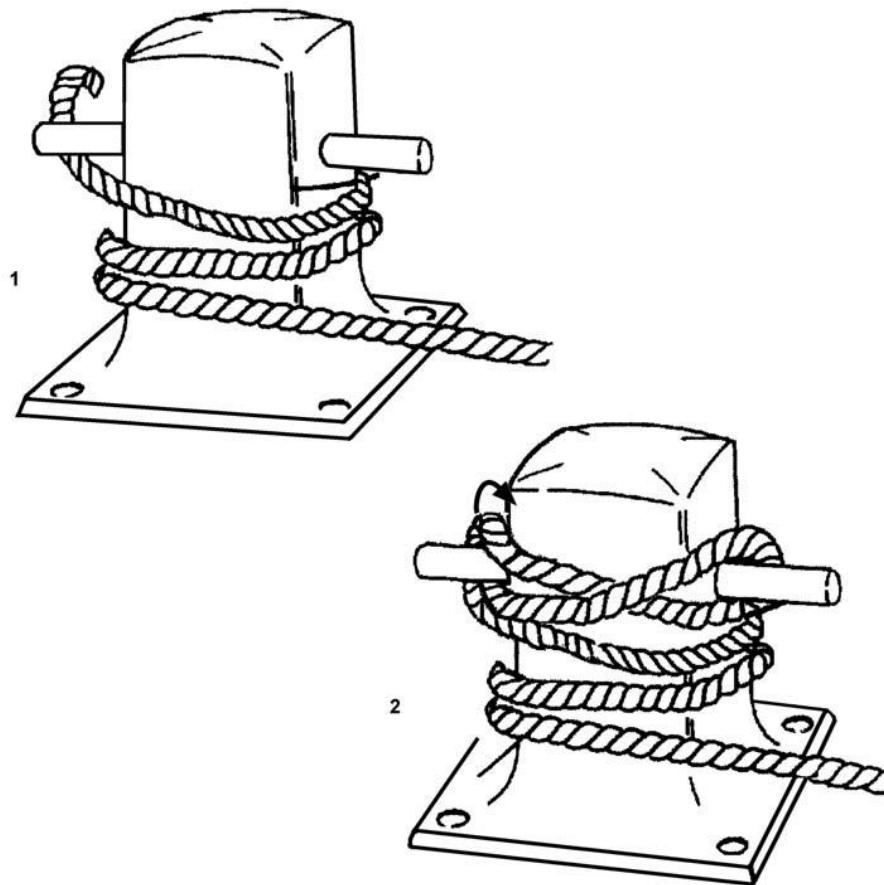
#### E.2.d. Securing a Line to a Sampson Post

A Sampson post is a vertical timber or king post usually on the stern deck [as is the case on Rescue One at Great Salt Lake](#). Sampson posts on Division vessels are used for towing. The following procedures describe how to secure a line to a Sampson post (See **Figure 7-38**)

| Step | Procedure   |
|------|---|
| 1    | Make a complete turn around the base of the Sampson post                            |
| 2    | Form several figure eights around the horns of the Sampson post. (Stand is 3 turns) |

NOTE: When using a Sampson post to secure a tow, there is a technique of taking one wrap around the post and one end of the bit to create the proper amount of friction as the tow line is being played out

for proper distance between tow vessel and vessel being towed. This technique allows for safe paying out of line and then bighting (securing the line) easily and safely.



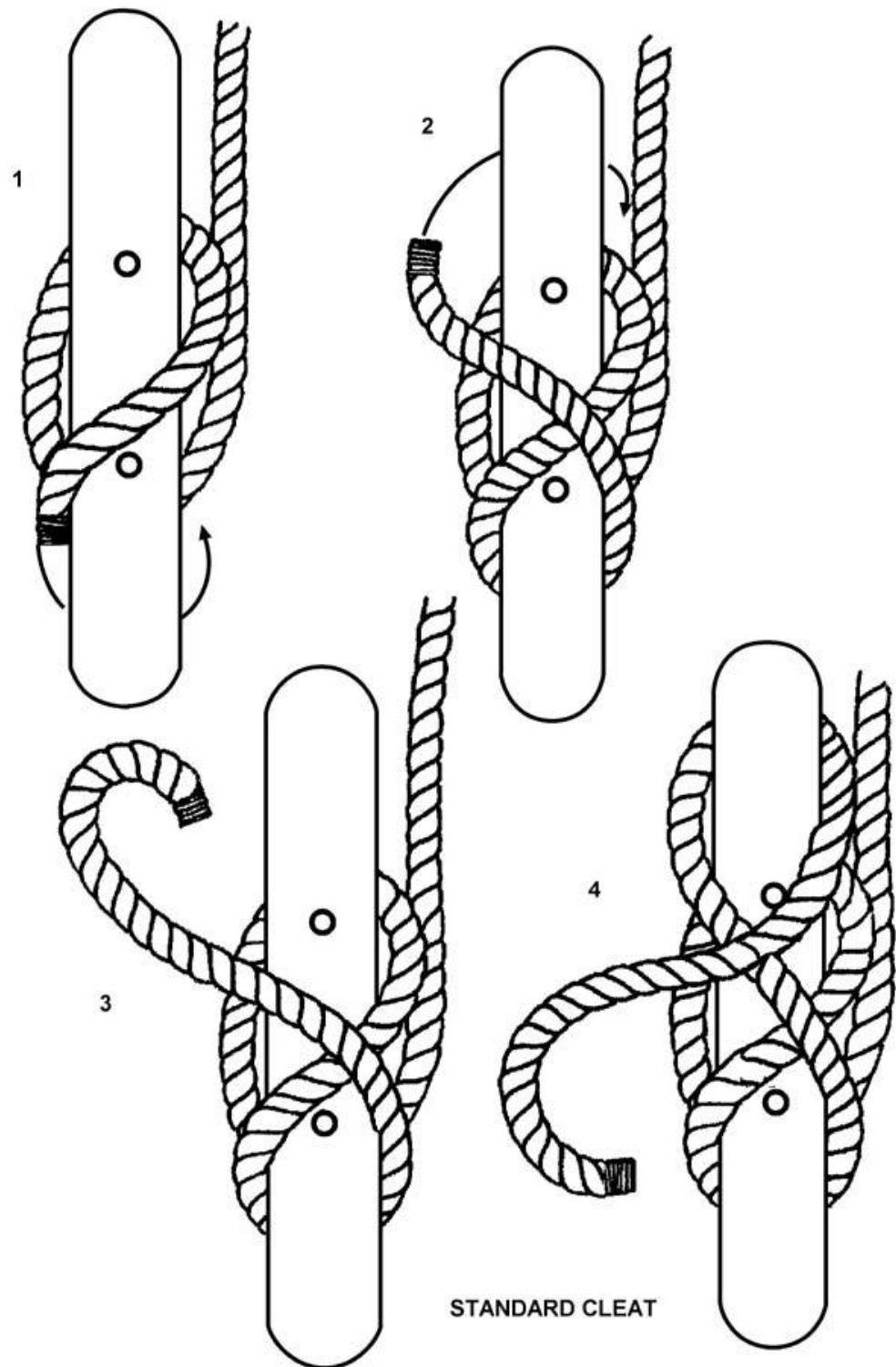
**Figure 7-38**  
**Securing a Line to a Sampson Post**

NOTE: The figure does not show extra figure eights.

#### E.2.e. Securing a line to a Standard Cleat

The following procedures describe how to secure a line to a standard cleat (See **Figure 7-39**):

| Step | Procedure   |
|------|---|
| 1    | Make a complete turn around the cleat.  |
| 2    | Lead the line over the top of the cleat and around the horn to form a figure eight. |
| 3    | If possible, make two more figure eights.   |



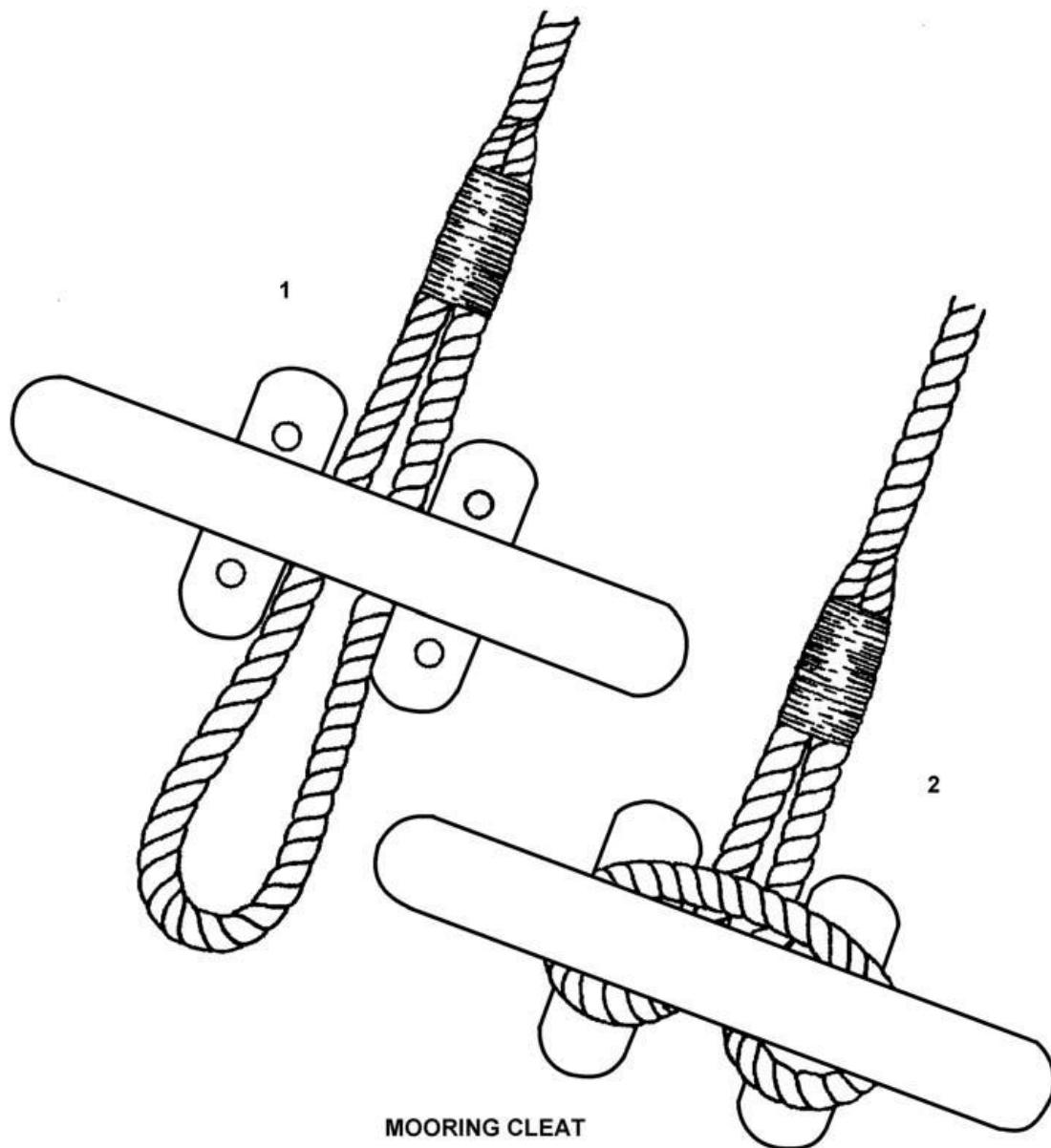
**Figure 7-37**  
Securing a Line to a Standard Cleat

NOTE: The figure does not show extra figure eights.

### E.2.f. Securing a Line to a Mooring Cleat

The following procedures describe how to secure a line to a mooring cleat (See **Figure 7-40**):

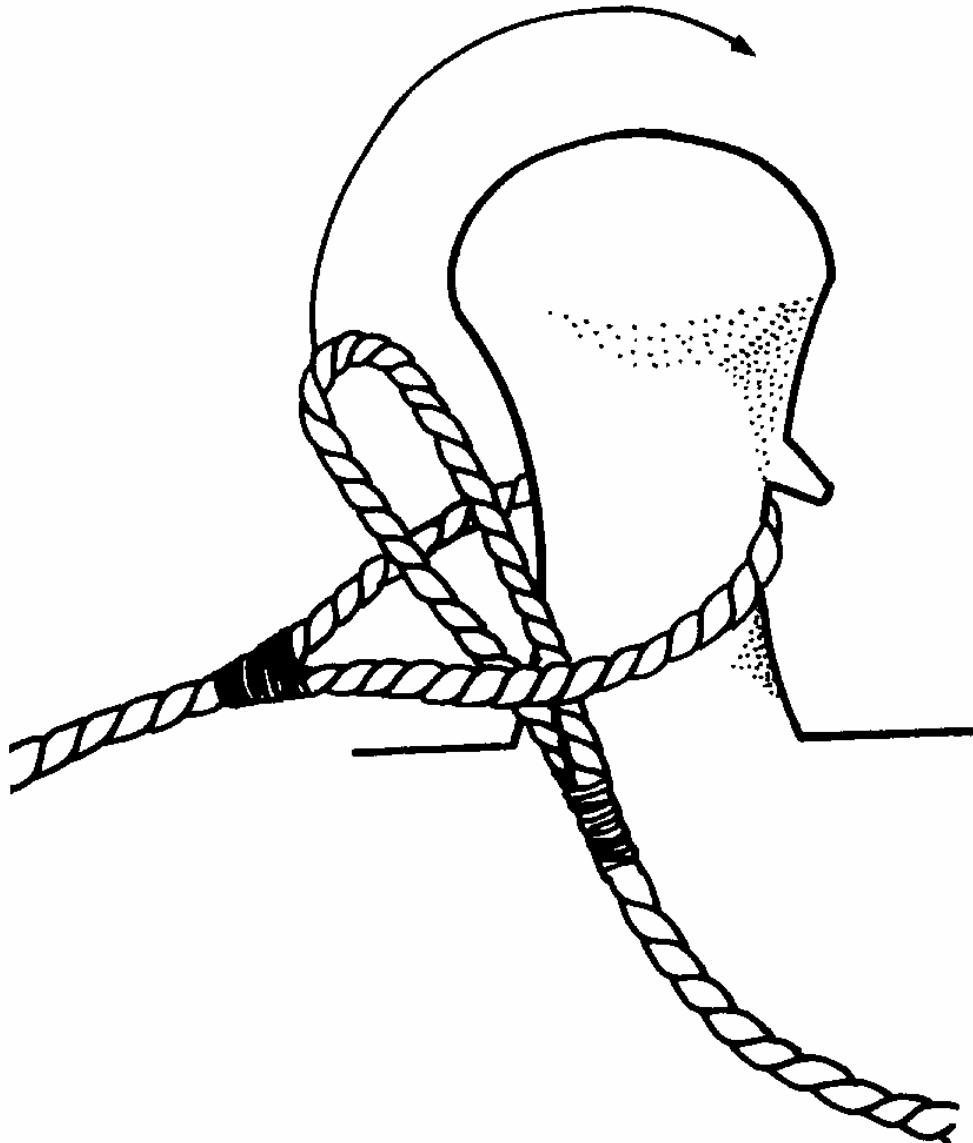
| Step | Procedure  |
|------|--|
| 1    | Feed the eye of the line through the opening.              |
| 2    | Loop the line back over both horns and pull the line taut. |



**Figure 7-40**  
Securing a Line to a Mooring Cleat

### E.2.g. Dipping the Eye

When two lines with eye splices are placed on a bollard, it may not be possible to remove the bottom line until the top line is removed. By dipping the eye, both lines can be placed for easy removal. The following procedures describe how to dip the eye (See **Figure 7-41**)



**Figure 7-41**  
**Dipping the Eye**

### E.2.h. Securing a Towline

The towline is probably the hardest worked line on a boat. Able to handle tremendous strain, it still is a possible danger to anyone working near it. Towlines should be made up so slack can be paid out at any time or so the line can be slipped (cast off) in an emergency. Division vessels have different styles of

tow bitts and must be made up securing the tow while allowing for easy adjustment. Additional information on the use of towlines is provided in *Chapter 17, Towing*.

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