CHAPTER II
ROPES AND KNOTS

Rescue work frequently calls for the use of rope. It is one of the most important tools for rescue personnel. It is essential that all rescue personnel have a thorough knowledge in the use, care, and characteristics of rope.

A. TYPES OF ROPE:

1. Manila - This is a vegetable fiber rope and is no longer considered safe for rescue work.
2. PolyPlus - Synthetic rope made of polyester, polyethylene, and polypropylene which is not considered acceptable as a lifeline rope.
3. Kernmantle - Kern means (core), mantle means (sheath). This rope is designed with a braided sheath over a continuous stranded core.
4. Static - It has less than 6% elongation factor when a load equaling 10% of its minimum breaking strength is applied. Example: a 100' section of 1/2" kernmantle rope with a 9,000 lb. tensile strength, with a 900 lb. load applied to it should not elongate to more than 106'.
5. Low Stretch - It has between a 6% & 10% elongation factor when a load equaling 10% of its minimum breaking strength is applied. Example: a 100' section of 1/2" kernmantle rope with a 9,000 lb. tensile strength, with a 900 lb. load applied to it should elongate between 106' and 110'.
6. Dynamic Kernmantle - This rope is used for rock and mountain climbing, and is mentioned only for identification purpose. It is designed to stretch when loaded. Consult manufacturer for specifications.

B. STRENGTH OF ROPE

The strength of a rope is governed by its size (diameter), its condition, and by the care with which it is used. Rope is made to a standard set of specifications and when new, has a stated "breaking strength" or tensile strength. In rescue work, personnel should never subject rope to the "breaking strength". When loading a rope, rescue personnel should not exceed one-fifteenth of the "breaking strength". This is referred to as the "safe working load". The S.W.L. is used to take care of age, normal wear, knots, and sudden jerks on the rope.

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<thead>
<tr>
<th>ROPE SPECIFICATIONS</th>
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<td>Size</td>
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<td>Inches</td>
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C. CARE OF ROPE

The following rules should be observed in the care of rope.

1. New rope should be stretched its entire length before use.
2. Avoid sharp or rough edges on surfaces over which the rope passes. Use padding, when necessary, to protect the rope.
3. Avoid using blocks or pulleys too small for the rope. Undersized blocks or pulleys will rub away the fiber crowns (outside surface).
4. Avoid sharp bends and kinks.
5. Never allow the rope to come under sudden strain, jerk, or shock load.
6. Do not drag rope on ground. Sand and grit will work into the rope, cutting and causing abrasions to the fibers.
7. Ropes should be kept clean, dry, and free of petroleum products. It should be stored in a bag or coiled and placed out of direct sunlight and in a compartment away from the petroleum products.
8. Ropes should be kept free from hydrocarbon products, mists or vapors, acids, alkalis, paints, etc.
D. TERMINOLOGY

1. Running end - The running end is the free or working end of the rope.
2. Standing part - The part of the rope which takes the load.
3. Bight - A bend or U-shaped curve in a rope. An open loop in a rope. (See Figure 7, page 18)
4. Whipping - Binding the end of a rope with twine or cord to prevent untwisting or fraying.
5. Seizing - Binding the running end to the standing part of the rope with twine or cord.
6. Anchor - Fasten to some immovable object.
7. Round turn - One complete turn around an object or another rope. (See Figure 8, page 18)
8. Hitch - A closed loop of a rope. (See Figure 9, page 18)
9. Half-hitch - A loop formed on a rope by passing the running end of a rope around an object and under the standing part so that, when pulled, one part of the rope binds the other.
10. Mouthing - Tying a piece of cord across the jaws of a hook to prevent a rope or sling from jumping out when the weight is temporarily supported.
11. Frapping - The binding together of a lashing between two poles.
12. Marrying - Twisting the running end of a rope around the standing part, once a knot has been tied or grasping together all ropes between two blocks or between two points.
13. Body cord - A rope carried by each rescue team member, usually tied around the waist. It serves many purposes, such as securing ladders, lashing a stokes basket, etc. This rope is 25' x \( \frac{1}{4} \)", made of static kernmantle.

E. KNOTS

Primarily, a good knot must hold without slipping. Next, it should be easy to tie and untie once it has been used. The choice of the best knot, bend, or hitch depends on the job it has to do. A sound knowledge of knots is required of rescue personnel for the joining and securing of ropes. There are many knots that will hold and be safe, but those below are adequate to complete a safe rescue operation.

1. Overhand Knot

The overhand knot is the most commonly used and the simplest of all knots. It may be used to prevent the end of a rope from untwisting or fraying and is sometimes tied onto the end of a rope to prevent the rope from running through a block. It is also used to serve as part of another knot. To tie the overhand knot, form a loop, making sure the running end of the rope crosses the standing part, then pass the running end around the standing part and through the loop. (See Figure 10, page 18)

2. Figure-of-Eight

This knot is used as a stop and is larger, stronger, and easier to untie than an overhand knot. It is equally secure but is less damaging to the rope fibers. It is used to prevent the end of a rope from running through a block and is also a temporary whipping.

To tie this knot, holding the standing part of the left hand, pass the running end over the top of the standing part, forming a loop. Then pass the running end under and around the standing part. Next, pass the running end down through the loop you have formed. Draw the running end tight, and the knot should resemble the figure of "8". (See Fig. 11 on page 18)
3. Half Hitch

This is the basis of many knots. It is also used to attach a rope to poles, hooks, etc. when raising or lowering. To tie, pass the running end around a pole, rope, etc. and over the standing part, so that, when pulled, one part of the rope binds on the other.

The half hitch used by itself will hold against a steady pull on the standing part, but it is not a very secure hitch and is mainly used for temporarily securing the free end of a rope. (See Fig. 12 on page 18)

4. Clove Hitch

This hitch is the basis of many securing knots. It is used as the beginning of lashings on "A" frames, tripods, and derricks. It is also used for hoisting timbers, rescue tools, and other equipment. A clove hitch may be tied at any point in a rope - at the end or in the middle. (See Figure 13 on page 16)

To tie a clove hitch with the end of the rope, pass the running end over the pole, and bring it out underneath the standing part. Cross over to form a half hitch. Holding the rope where it crosses with the thumb and forefinger of the left hand, pass the running end around the pole again above the first half hitch. Drop the running end. With the right hand, reach down through the loop (at end of thumb and forefinger) and grasp the running end; pull it through. To tighten, pull the running end and standing part opposite each other. (See Fig. 14 on page 18)

To tie in the middle of the rope, form two counterclockwise loops, one in the left hand and one in the right hand; pass the right hand loop in front of the left hand loop. Place loops together. Pass over the pole, and draw tight. (See Fig. 14 on page 18)

5. Double Sheet Bend or Becket Bend

This knot is used to join two ropes together. It can be used on ropes of equal or unequal size and for joining wet ropes. It will not slip or draw tight under heavy loads.

To tie a double sheet bend, form a bight in the larger rope if they are unequal in size. Pass the running end of the smaller rope through the bight, and form a half hitch around the two thicknesses of the larger rope. Continue with the running end, and make another turn around the two thicknesses of the larger rope and toward the bight. (See Fig. 15 on page 18)

6. Bowline

A bowline forms a non-slipping loop in the end of a rope. It is a good securing knot and is used frequently in raising and lowering heavy objects, tools, and persons being rescued. (See Fig. 16 on page 18)

To tie a bowline, form an overhand loop in the left hand. Pass the running end through the underside of the loop, around the standing part and back through the loop. Draw tight.

7. Bowline-on-a-Bight

This knot forms two non-slipping loops. It is also used for the leg loops when tying a "life basket."

To tie, double the rope and form an overhand loop in the left hand. Pass the doubled end (bight) up through the loop. Open the bight over the two loops, and carry it up to the standing part. Pull down tightly to dress the knot down. The two loops have to be big enough to go over the legs of the victim. (See Fig. 18-A, B, C & D on page 20)
8. Double Bowline

The double bowline forms three non-slipping loops and is used as a life basket for lowering a person. One loop supports the chest, and the other two go on the legs.

To tie: Proceed as if tying a bowline except the rope is double and running end is long, to form the third loop. After forming the loop and passing the running end through it, hold the loop with the left hand at belline, and extend the right hand, holding the running end to arm's length at eye level. This will give the proper loop size. To determine the amount of rope needed to form a double bowline, measure from hip to hip, standing on the rope with it doubled. (See Fig. 19-A, 19-B, 19-C, 19-D on pages 21, 22, 23, 24)

9. Life Basket

This knot is used for safety and comfortable support in raising and lowering casualties or rescue personnel. It is easier and more comfortable to use than a double bowline.

To tie: Begin by tying a bowline-on-a-bight, leaving the short end of the rope about three feet long.

Next, form a half hitch around the chest with the standing part. With the standing part, form a loop at the half hitch on the chest. Pass the running end through the loop from the front side; go around the standing part and back through the loop. Draw tight. (See Fig. 20-A, 20-B, 20-C, 20-D on pages 25, 26, 27, 28)

10. Timber Hitch

The timber hitch is used for moving heavy timbers or poles. It should be used in conjunction with a half hitch at the upper or larger end of the object being raised. The pressure of the coils, one over the other, holds the timber securely. The more tension applied, the tighter the hitch becomes. It will not slip under a load but will loosen easily when the strain is released.

To tie, pass the running end around the timber, making a half hitch on the standing part of the rope, leaving the running end long enough to be twisted two times around itself.

11. Round Turn and Two Half Hitchs

This is used for securing or anchoring a rope to a pole, picket, or holdfast

To tie: Make a round turn on the object, and tie two half hitchs onto the standing part of the rope. Seizins is not required in all cases.

12. Draw Hitch

This knot is useful for easy and quick release, remote from the knot. It is used to hold the poles together for lashing of "A" frames or tripods or at any other time a quick release is desired.

To tie: A bight is formed in the center of the rope and passed under and around the pole or object being tied. A bight is then formed in the standing part and passed through the first bight. Holding onto the second bight, pull the running end until tight. A third bight is formed in the running end and passed through the second bight. Holding onto the third bight, pull the standing part until tight. Repeat this step one more time. To untie, pull first on the standing part and then on the running end. Note: Two or three bights are acceptable.

13. Cats paw

A cats paw can be used for fastening an endless sling to a hook, or it can be made at the end or center of a rope for fastening the rope to a hook.

To tie, twist two loops in the rope, making two or three turns. The loops should be twisted in opposite directions. Place two loops on the hook, and mouse the hook. (See Fig. 17 on page 19)
Cats Paw
Figure 17
Double rope

Overhand loop

Bight end up through and down

Bring bight up and around entire knot

Open bight here

Pull

Bowline-On-A-Bight
Figure 18
Double Bowline Used As A Life Basket
Figure 19-A
Double Bowline Used As A Line Basket
Figure 19-B
Double Bowline Used As A Life Basket
Figure 19-C
Double Bowline Used As A Life Basket
Figure 19-D
Leg Loops For Life Basket
Figure 20-A