

ROPES KNOTS AND LINES

Ropes form an essential part of the Fire Brigade equipment. There is hardly an operation in firefighting whether it be effecting a rescue getting a length of hose up a building, working on a ladder or making fast the suction when working from open water which for most times call for the use of a rope. The factor of safety employed should be considered together with the purpose for which the rope is used, the conditions of service and the condition of the rope.

Ropes may either be of fiber or metal or sometimes mixed construction. The general description applied to all forms of fiber of rope, line and twine is CORDAGE and ropes of metal are referred to as WIRE ROPES.

NATURAL FIBER ROPE

Rope, as generally used in the fire service, is made principally of:

- a) *Italian Hemp* - *A base fiber obtained from the stalks of the hemp plant. The fiber is soft, pliable and considerably stronger than other hems.*
- b) *Manila* - *A fiber obtained from the leaf sheaths of the Abaca plant.*
- c) *Sisal, Coir and Cotton* - *To a much less extent.*

Italian Hemp - is acknowledged as the best fiber for Fire Brigade rope, particularly for lines used for rescue purposes, as it is less likely to swell when wet and owing to the softness of the fiber is more flexible.

Manila - on the other hand, makes an excellent general purpose rope and is less expensive.

Sisal - is not normally used since it swells considerably when it is wet and is liable to be slippery.

MAN-MADE FIBER ROPE

The two principal fibers used for cordage are:

- a) *Nylon* - *A man-made fiber with a complex form structure of Carbon, Nitrogen, Oxygen and Hydrogen.*
- b) *Polyester-* *A fiber derived by chemical synthesis from the products of mineral oil. Cracking, it is sometimes marketed under the trade name Terylene.*

Both are extruded and drawn into very fine filaments of silvery white sheen and soft silky texture. Accurately controlled manufacturing conditions result in uniformity of strength throughout the whole length of the rope. The finished rope is smooth, flexible and pleasant to handle. Tensile strength is an important property of all rope and both nylon and terylene are outstanding in this respect being approximately twice as long, size for size as rope made from the highest grade vegetable fiber. Other valuable properties of man-made fibers are:

- i. *Ability to absorb shock loads.*
- ii. *Ability to withstand repeated loading of high order without failure.*
- iii. *Little swelling on immersion in water.*
- iv. *They can be stored wet without degradation by rot or mildew.*

Nylon rope is also highly resistant to alkalis while because of the comparatively low strength of terylene, it is suitable for use as a rescue line.

Wire Rope

Wire rope is a combination of steel wires arranged around a central fiber core. The breaking load of wire is considerably greater than that of fiber rope of equivalent size but it is far less flexible and more difficult to handle. Its uses by the Fire Brigade is therefore generally limited to equipment which is operated by means of a winch, such as wheeled escapes, turntable ladders and some extension ladders.

METHOD OF MANUFACTURE

Rope is normally made in length not exceeding 120 fathoms (720ft. 219m). After processing, the fiber are twisted or plaited together to form rope. Rope may be twisted or 'laid up' either right hand or left and is then known as right hand or left hand lay. The direction of twist or lay is now referred to by the symbols 'S' and 'Z' and can be determined by looking at the rope. If the strands run away from the body from left to right, it is 'Z' or right hand lay, if from right to left it is 'S' or left hand lay.

The size of rope is expressed in terms of its circumference. The size is actually determined by the size of the yarns, i.e. the number of the threads in the yarn and the number of yarns in a strand.

DAMAGE TO ROPE

Throughout its life, rope will deteriorate to a greater or lesser extent according to the use, care and maintenance it is given. Many of the causes of deterioration show early signs which will be revealed by careful examination. These examinations should be carried out periodically, particular in the case of lines used for rescue purposes, at the same time as any load test to which the line is subjected.

Mechanical deterioration can be caused either through external abrasion or breakdown of the external fibers as result of dragging along the ground, kinking and load of chaffing on sharp edges.

Chemical deterioration, particularly in natural fiber rope, may be caused by exposure to acid, alkalis or whether conditions or by submersion in water for any considerable time. Lines should be stored as far as possible, in a cool dry place with plenty of ventilation. They should not be stored damp, or

mildew will set in. Rope, like hose, is more liable to damage when wet, therefore as far as possible it should be kept dry especially when in use.

Man-made fiber rope is less affected by chemical deterioration and is free from attack by rot or mildew. However, all fibers, whether vegetable or synthetic, are affected by temperature. Deterioration of man-made fibers start at temperatures about 200°C, and part almost immediately. The ignition temperature of natural fibers is about the same.

If a line becomes dirty, it should be washed and allowed to dry in the same way as canvas hose.

TERMS USED IN RELATING TO CORDAGE

Belay	To make a line fast. This is usually applied to running lines.
Bend	To fasten a line to another line or an object.
Bight	The middle part of a length of line. The term also refers to a loop of a line and to ‘make a bight’ is to form a loop.
End	The short length of either end of a line, which may be formed into an eye, or used for making a bend or hitch with which to secure it. The end of a line is also that length of rope left over after making such an eye, bend or hitch.
Hitch	A simple fastening of a line to some object by passing the line around the object and crossing one part over the other.
Line	Cordage cut to a specific length for a particular purpose, eg. lowering line, rescue line, belt line. The term derived from the use of ropes at sea and is commonly used to distinguish between the manufacture’s products in bulk (eg. 120 fathoms [219m] of 2” [51mm] Mania rope, etc. and the lengths which are cut from it.
Part	To the end.
Pay Out	To ease out to slacken a line.
Reeve	To thread a line through a block.

Rope	The ultimate product when three or more strands are laid together to form a helix round a central axis. The term 'rope' should not be used when the ultimate product has a circumference of less than 5/32" (4mm); in this case cord or thread would be used.
Running End	The free end of a line.
Running Part	The moving part of a line is loose and is used to hoist or lower.
Seizing	A seizing is used to fasten together two ropes or cables or two parts of the same rope or cable, to prevent them moving in relation to each other.
Splicing	A method of joining the ends of two ropes together, or of making an eye in the end of a rope, by unlaying the strands for a short distance and then interlocking the strands of the two parts into each other.
Standing	The part of the bight of a line which is nearest the eye, bend or hitch, in contrast.
Strand	The product obtained by twisting together two or more yarns.
Thread	A slender cord made from two or more yarns or filaments twisted together.
Twine	A number of yarns twisted or laid to produce a balanced twisted structure of continuous length.
Whipping	The binding around of the end of a line to prevent the strands from unlaying.
Yarn	The product of spinning together fibers of rectangular or irregular staple length so that they are bound together by twist to form a continuous length.

KNOTS BENDS AND HITCHES

Cordage forms an essential part of Fire Brigade equipment. There is hardly an operation in firefighting, whether it be effecting a rescue, getting a length of hose up a building or making fast the suction when working from open water, which does not call for the use of a line of one type or another.

Types Of Lines

Rescue Lines, Lowering Lines, Punch Lines, Tail Lines, Long Lines, Short Lines, Escape Lines, Guy Lines, Bobbin Lines, Belt Lines, Guide Lines and Personal Lines.

The list of knots, bends and hitches given in this section is by no means exhaustive and additional may be used, but for normal Fire Brigade purposes, those described are sufficient.

Every firefighter should not only be familiar with each of these knots, but itself. This is effect by means of a knot or hitch. **The requirements of good knots are:**

- i. that it shall carry out the function for which it is employed, safely and without slipping.
- ii. that it shall be easy to work
- iii. that it shall not damage the line.
- iv. that it shall be easy to untie.

The following knots and their lines will be taught as a practical part of this training:

- | | | |
|----------------------------------|---|--|
| Overhand Knot | - | Tied in a burst or damage length of hose to identify it while it is still laid out. |
| Figure of Eight Knot | - | An alternative to the overhand knot, it is used as a stopper to prevent a line unreeving through an eye or block. |
| Reef Knot | - | One of the most useful of all knots for a variety of purposes. |
| Fisherman's Knot | - | Does not join tightly when subjected to heavy strain, or when left tied for long periods. It is generally used by Fire Boat personnel. |
| Sheet Bends | - | Used to join lines of unequal thickness. A double sheet bend should be used when joining wet lines, or lines of man-made fiber whether wet or dry as the extra turn makes the not more secure. |
| Clove Hitch | - | Used to make a line fast to a spar, or to secure a line to any object, such as a pump suction. Also useful for hoisting items of Fire Brigade equipment. |
| Rolling Hitch | - | A variation of the clove hitch but with the advantage that it will not slip when subjected to a sideways pull. |
| Rolling Turn and Two Half | - | This combination is used to secure a line to a spar, ring or any |

round object, or to another line. It has the advantage that whatever stress is applied, the knot will not join, yet after the weight is removed, it is easy to untie.

- Bow Line** - Forms a non-slipping noose and is useful for lowering or raising purposes, or to attach a line around the waist. There are other variations eg. Running Bow Line and Bow Line on the bight.
- Timber Hitch** - This knot is used to secure a line for hoisting a bulk of timber, a plank or any irregular object.
- Steep Shank** - It is used to shorten the bight of a line temporarily cutting it.
- Bow Line On The Bight** - This knot is used as a sling for rescue purposes. For this, the Two bights which are formed are passed one under the knees and the other under the armpits of the person to be rescued. The knot should be made so that the loop to go around the body is somewhat smaller than the loop for the legs. The respective lengths can be adjusted as required by slackening the knot and pulling the loops to the desired size.
- Yosemite Bow Line** - This is a variant of the basic bow line which gets around the problem of the knot loosening itself by taking the end of the rope and threading it back through the knot. This is a neat alternative to using a half-stitch to secure the end of the rope and the resulting knot has the strength of a figure of eight.
- Tape / Water Knot** - This knot is primarily used for tying tapes into slings for caving or climbing. The ends of the tape emerging from the knot should be secured to the tape loop using half hitches or insulating tape.
This knot is tied so that the load bearing tape emerges from opposite sides of the knot so it will sit naturally with the sling is in use.

Other useful knots are the Waterman's Hitch and Cat's Paw. The correct method of tying a knot is not difficult to master and with practice, it should eventually become an ordinary routing in the duties of a firefighter.

Bowline on the Bight

This is another double loop knot suitable for rigging Y-belays. It has the advantage that is a bit less bulky than the figure-of-eight on the light.

Yosemite Bowline

This knot was sent to be by Bonnie Crystal.

This is a variant of the basic bowline which gets around the problem of the knot loosening itself by taking the end of the rope and threading it back through the knot

Tape/Water Knot

This knot is primarily used for tying tapes into slings for caving and climbing. The ends of the tape emerging from the knot should be secured to the tape loop using half hitches or insulating tape.

This knot is tied so that the load bearing tape emerges from opposite sides of the knot so it will sit naturally when the sling is in use.