HAGGIE® STEEL WIRE ROPE
Lower Germiston Road
Heriotdale
Gauteng
Tel: +27(0)11 620 0000
Fax: +27(0)11 620 0260
www.scaw.co.za

STEEL WIRE ROPE - AN INTRODUCTION

The art of rope making dates back to the earliest recordings of history. The earliest ropes were made of natural fibres. It was only during the 19th Century that the first steel wire ropes were made.

1.0 Components of a Steel Wire Rope

A wire rope is often compared to a machine, with a series of components all working together to achieve a desired outcome. In its simplest form a rope consists of as little as three wires, but most applications require ropes with constructions which are significantly more complex. The figure below illustrates a cross-section of a steel wire rope; the components of a wire rope are identified.

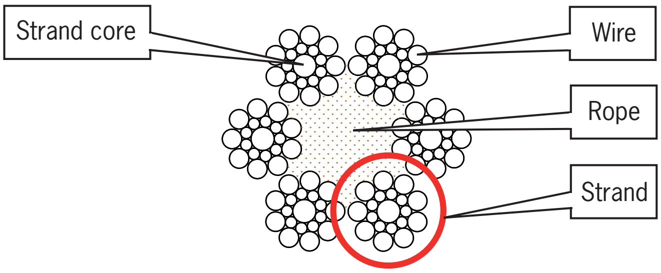

Figure 1: Cross-section of a steel wire rope with the components of the rope identified.

It can be seen that this rope is a fairly complicated piece of equipment. In this case six strands are helically formed around a core of fibre. Each strand is made up of several wires which are themselves formed around a strand core.

- **Wire:** A wire is the most basic unit used to make a rope.
- **Strand Core:** Most strands have a single steel wire as a strand core. To achieve more flexibility non-metallic cores are used. Cores of shaped strands have the additional function of providing the basis for the shaped core. Examples of shaped strand cores are shown in Figure 2 below.
- **Strand:** A series of wires twisted together over a strand core (often a strand core is a single wire). Strands can either be of equal lay or unequal lay. These are described later in this document.
- **Rope Core:** All ropes with more than three strands require a rope core. Rope cores are required to ensure constructional stability and provide sufficient support to avoid severe inter-strand contact.

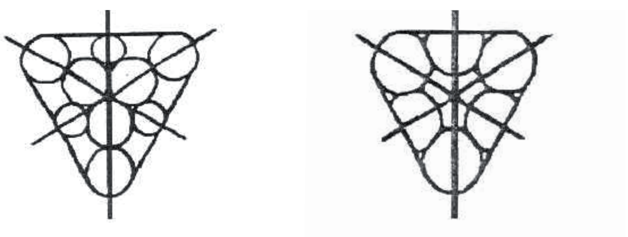

Figure 2: The figure shows a plated triangular strand (left) core alongside a Brangle strand core (right).

2.0 Rope Constructions and Types

When rope is to be selected for a duty it is necessary to evaluate the particular characteristics required for the application and to choose the rope possessing these qualities in the best combination. This frequently entails a compromise and it is suggested that, in cases of doubt, rope manufacturers or their representatives be consulted in choosing the most suitable rope.

Steel wire ropes are used essentially for transmitting tensile forces. The main characteristics which make them so well suited to this function are flexibility and their strength in terms of both mass and diameter. Various rope constructions also possess other characteristics in varying combinations, such as resistance to abrasion, to repeated bending, to shock loading and to lateral pressure. The factors to be considered when making a choice of rope for optimum performance are described in the following sections.

2.1 Single Strand Ropes

These vary in size from 0.5 mm (control cables) up to 100 mm or more in diameter (bridge cables and guy ropes) the arrangement of wires in the strands being similar to one strand from a single layer round strand rope. Included in this category are ropes of the full-locked coil and half-locked coil types. The latter are used in South Africa for guide ropes in mine shafts and track ropes in aerial cableways. Single strand ropes are generally laid up with certain layers of wire left- and rig right- hand, with the object of minimising their tendency to spin and/or elongate under load.

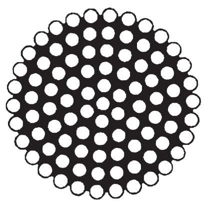

Figure 3:
Single strand bridge rope

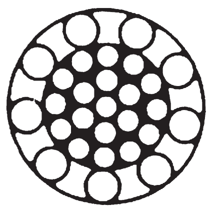

Figure 4:
Half locked coil guide rope

2.2 Single Layer Stranded Rope

These are by far the most usual type, the number of strands being six in nearly all cases. For traction type lifts, however, eight strand ropes (fig. 6) are generally used. Nine strand ropes are occasionally required for extreme flexibility, but their strength is almost 20% lower than a six strand rope of the same size, and resistance to crushing is poor. Three strand ropes are occasionally used for highway guards, borehole surveying and paravane towing rope. Four strand ropes were at one time fairly popular as crane ropes as their tendency to spin was slightly less than that of a six strand rope. In general, however, the best combination of strength and resistance to crushing and abrasion is to be found in a six strand rope which is nowadays in general use for running ropes.

The strands may be laid up around a fibre core, an independent wire rope core (IWRC) or a wire main core (WMC). The fibre core may be made of sisal, in which case it is usually well impregnated with a suitable lubricant, or of a synthetic fibre such as polypropylene. The IWRC is usually made up of six strands of seven wires over a wire main core and is to be preferred as a core, where resistance to crushing or heat is required. The WMC is usually made with the same construction as the outer strands and in ropes of over 6 mm diameter, is limited to use in standing ropes only or certain non-spin ropes.

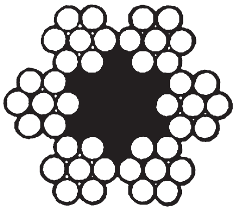

Figure 5:
6x7(6/1)/F haulage rope

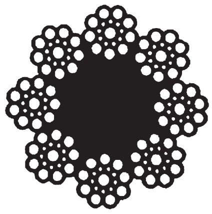

Figure 6:
8x19(9/9/1)/F Lift rope

2.3 Multi-Strand Non-spin Ropes

When tension is applied to a single layer rope, it tends to untwist. When the end of the rope is unconstrained and any appreciable amount of spin is undesirable, non-spin rope should be used. This type consists of a conventional single layer rope over which is laid an additional layer (or layers) of strands in the opposite direction to obtain torque balance. Due to its complexity, this type of rope is not quite as robust as conventional rope and requires more careful handling.

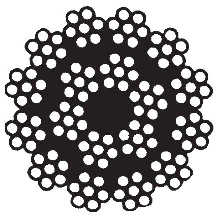

Figure 7: 18 Strand, non-spin rope
12x7(6/1)/6x7(6/1)/F

3.0 Types of Strand Construction

3.1 Unequal Lay Strands

The strands for this type of rope are made by forming a strand centre, of say 6 wires, around a core wire and then adding layers of wires until the requisite strand size is produced. The basic principle of this type of strand is that all wires, with the exception of the central core wire, should be of equal length. This necessitates an increase in lay length, with each successive layer of wires. Consequently, the small angle formed between the wires in successive layers produces indentations. Under operating conditions involving severe pressures or repeated bending, these indentations form stress concentration points which may hasten fatigue.

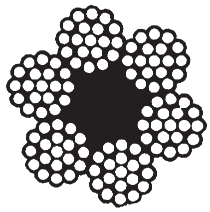

Figure 8:
6x19(12/6/1)/F

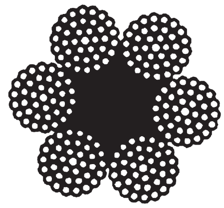

Figure 9:
6x37(18/12/6/1)/F

3.2 Equal Lay Strands

In this type of rope the strands are so designed, that the wires of one layer lie in the grooves formed by the layer below (fig 10 & 11). The lay lengths of successive layers of wire are therefore all equal. The absence of interlayer indentation has considerable advantages as regards the rope's resistance to crushing and bending fatigue.
Ropes in this category include the 6x19(9/9/1)/F Seales, 6x19(6+6/6/1)/F Warrington, 6x25(12/6+6/1)/F Filler wire and 6x36(14/7+7/7/1)/F Seales Warrington and are used for earthmoving machinery, heavy duty cranes and other applications involving arduous operating conditions.

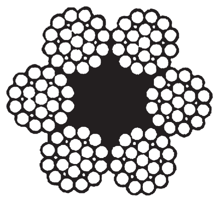

Figure 10:
6x25(12/6/6/1)/F

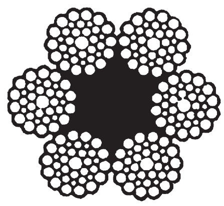

Figure 11:
6x36(14/7+7/7/1)/F

3.3 Triangular Strands

The cross section of this type of strand approximates to an equilateral triangle with rounded corners. Various types of triangular core are used which may be covered by either one or two layers of wires (simple or compound type respectively).

The formation is of necessity unequal lay. Ropes with this type of strand are nevertheless highly resistant to crushing because of their compact formation, and also to abrasion due to the greatly increased wearing surface as compared with a round strand rope. They are somewhat costly to make in the smaller sizes but in diameters of about 26 mm and upwards are widely used as mine hoist ropes.

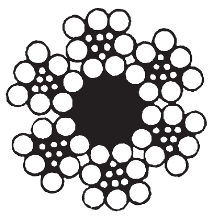

Figure 12:
6x13(7/6Δ)/F

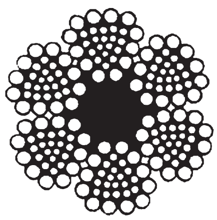

Figure 13:
6x30(12/12/6Δ)/F

HAGGIE® STEEL WIRE ROPE
Lower Germiston Road
Heriotdale
Gauteng
Tel: +27(0)11 620 0000
Fax: +27(0)11 620 0260
www.scaw.co.za

3.4 Ribbon and Flattened Strands

These are used as outer strands in certain non-spin rope constructions and comprise usually from 6 to 10 wires laid up in ribbon formation. (Figure 14)

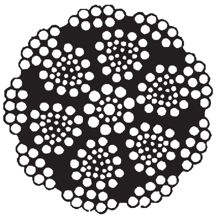

Figure 14:
15 Strand non-spin with 8 wire ribbon strands
9x8/6x29(11/12/6Δ)1x19(9/9/1)

3.5 Fibre Cored Strands

Where great flexibility and ease of handling is required, for example for slings, ropes having a fibre core in each strand (fig 15 & 16), in addition to the main rope core, are sometimes used; by far the most common of these is 6x24(15/9/F)/F as illustrated in Figure 15 below.

Fibre strand cores can also be used to produce an oval strand when made Lang's lay when increased resistance to abrasion is required. The shape of strand is then intermediate between round and ribbon. The most extensively used scraper rope in South Africa is the 6x6(6/F)/F as illustrated in Figure 16.

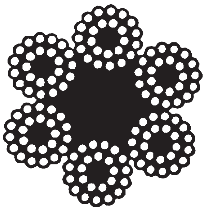

Figure 15:
6x24(15/9/F)/F

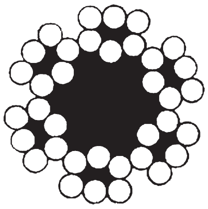

Figure 16:
6x6(6/F)/F

3.6 Fibre Covered Strands (Marline Clad)

Each strand in a rope may be covered with a fibre serving to improve traction and handling when it is to be used for instance, on a capstan winch. The loss in steel area in each strand is partially offset by using only five strands – thus reducing the size of the fibre main core.

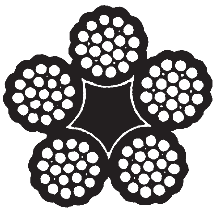

Figure 17:
5x19 Marine clad

3.7 Compact Strand

A more recent development in rope-making is the Compact Strand. In this case, after the strand has been formed, it is drawn through a die or rolled between compact rollers. This process subjects the wire to a certain amount of additional drawing and produces a strand in which the exterior wires are considerably flattened and the inner wires deformed so as to produce a plane surface contact instead of line contact between them.

This process increases the strength and fatigue performance of ropes made from these strands. However, there are limitations in both size and tensile strength.

Ropes made from this type of strand are usually termed UHP (Ultra High Performance), Dyformed or Compact Strand ropes.

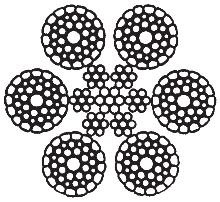

Figure 18:
6x41C(16/8+8/8/1)/WRC

4.0 Lay Configuration

4.1 Type of Lay

There are two general methods of laying up wire rope namely ORDINARY (or REGULAR) Lay and LANG'S Lay.

In the Ordinary lay rope the wires of the strands are laid in one direction and the strands are laid into the rope in the opposite direction, as shown in fig. 19. Ropes laid up in this manner are suitable for all general work.

Figure 19: Ordinary Lay

Figure 20: Lang's Lay

Fig. 20 shows Lang's lay rope in which both the wires in the strands and the strands in the rope are laid in the same direction.

SCAW METALS GROUP

HAGGIE® STEEL WIRE ROPE
Lower Germiston Road
Heriotdale
Gauteng
Tel: +27(0)11 620 0000
Fax: +27(0)11 620 0260
www.scaw.co.za

Rope made Lang's lay tends to wear more evenly than Ordinary lay rope owing to the rotational movement of the rope when at work and, since the wear is spread over a longer length of wire; the rope has greater resistance to fatigue when it becomes worn. Lang's lay ropes are slightly more flexible than Ordinary lay ropes of similar size and construction and their resistance to bending fatigues is better. They are extensively used for mine winding and haulage duty but no universal rule can be given regarding their application other than that their use is limited, as compared with the Ordinary lay rope.

A single layer Lang's lay rope should not under any circumstances be used for hoisting vertically without fixed guides, as in the case of cranes or similar duties where the load is suspended from a free end and the rope is able to rotate.

Triangular and Ribbon Strand non-spin ropes are almost invariably made Lang's lay as these strand formations are extremely prone to fatigue when made Ordinary lay.

Ribbon and flattened strand non-spin ropes are the only Lang's lay ropes which can be used with a free end, as this design of rope is almost completely non-rotating.

4.2 Hand of Lay

Hand of lay denotes the direction in which the strands are laid up in a rope.

Right Hand lay (fig 21) is the usual standard adopted by rope manufacturers and all ropes are supplied with this lay, unless otherwise specified by the customer.

The use of Left Hand lay rope (fig 22) is usually confined to ropes used for drilling purposes, to prevent unscrewing of rods, or in conjunction with Right Hand lay ropes on winders, cranes or elevators to counteract torque. Rope strength is not materially affected by the type or direction of lay, so breaking loads for the round strand ropes given in this catalogue, apply to both Lang's and Ordinary lay and to Left and Right Hand lay.

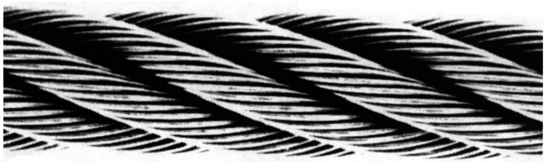

Figure 21: Right Hand Lay

Figure 22: Left Hand Lay

5.0 Tensile Strength of Steel

The tensile strength of the steel in the rope is specified by a number which represents the grade of steel and is the minimum of the allowable range of tensile strength to which a wire is drawn. The standard tensile strength offered is 1800 MPa. In addition, various grades of UHT wire up to a tensile strength of 2200 MPa can be supplied. In general, the range of strength used for wire for winding ropes is 200 MPa for standard grades and 250 MPa for Ultra High Tensile (UHT) grades.

6.0 Finish of Steel

When corrosion is a feature of operating conditions, ropes should be made of galvanised wire. Wires for winding ropes are generally galvanised before drawing (drawn galvanised). However, there is a limit to both diameter and tensile strength of wire which can be galvanised.

Drawn galvanised wire ropes have proved very successful in South African mines under corrosive conditions caused by both saline and acid water.

The resistance to corrosion of even semi-galvanised ropes has proved most effective and the use of ropes of this type in which only the inner wires of each strand are galvanised, is an established method of providing protection.

7.0 Preformation

Most ropes are preformed, the exception being some of the non-rotating rope designs and ropes of percussion drilling and some piling machines.

Since six strand drum winding ropes develop torque in service, it should never be assumed that because a rope is preformed it will be dead when cut. Proper seizings should always be applied before cutting any winding rope, especially after the rope has been put into service.

8.0 Lubrication

Unless otherwise specified, ropes for drum winders and winches are supplied fully lubricated with a heavy bituminous dressing, to provide protection in storage and initial lubrication in service. Ropes for friction winders are supplied with suitable protective dressings designed to avoid slip in service.