Wire rope

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Wire rope consists of several strands laid (or 'twisted') together like a helix. Each strand is likewise made of metal wires laid together like a helix. Initially wrought iron wires were used, but today steel is the main material used for wire ropes.

Steel wire rope (right hand lay)

Contents

History and materials

Modern wire rope was invented by the German mining engineer Wilhelm Albert in the years between 1831 and 1834 for use in mining in the Harz Mountains in Clausthal, Lower Saxony, Germany. It was quickly accepted because it proved superior to ropes made of hemp or to metal chains, such as had been used before.

Wilhelm Albert's first ropes consisted of wires twisted about a hemp rope core, six such strands then being twisted around another hemp rope core in alternating directions for extra stability. Earlier forms of wire rope had been made by covering a bundle of wires with hemp.

In America wire rope was later manufactured by John A. Roebling, forming the basis for his success in suspension bridge building. Roebling introduced a number of innovations in the design, materials and manufacture of wire rope.

Manufacturing a wire rope is similar to making one from natural fibres. The individual wires are first twisted into a strand, then six or so such strands again twisted around a core. This core may consist of steel, but also of natural fibres such as sisal, manila, henequen, jute, or hemp. This is used to cushion off stress forces when bending the rope.

This flexibility is particularly vital in ropes used in machinery such as cranes or elevators as well as ropes used in transportation modes such as cable cars, cable railways, funiculars and aerial lifts. It is not quite so essential in suspension bridges and similar uses.

Wire rope is often sold with vinyl and nylon coatings. This increases weather resistance and overall durability, however it can lead to weak joints if the coating is not removed correctly underneath joints and connections.

Lay of wire rope

The lay of a wire rope describes the manner in which either the wires in a strand, or the strands in the rope, are laid in a helix.

Left and right hand lay

Left hand lay or right hand lay describe the manner in which the strands are laid to form the rope. To determine the lay of strands

in the rope, a viewer looks at the rope as it points away from them. If the strands appear to turn in a clockwise direction, or like a right-hand thread, as the strands progress away from the viewer, the rope has a right hand lay. The picture of steel wire rope on this page shows a rope with right hand lay. If the strands appear to turn in an anti-clockwise direction, or like a left-hand thread, as the strands progress away from the viewer, the rope has a left hand lay.

Left-hand ordinary lay (LHOL) wire rope (close-up). Right-hand lay strands are laid into a left-hand lay rope.

Ordinary, Lang's and alternate lay

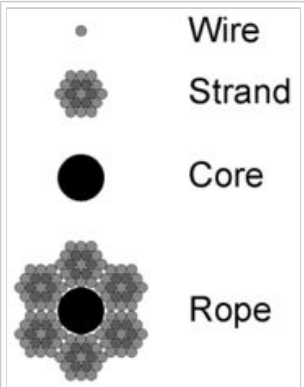
Ordinary and Lang's lay describe the manner in which the wires are laid to form a strand of the wire rope. To determine which has been used first identify if left or right hand lay has been used to make the rope. Then identify if a right or left hand lay has been used to twist the wires in each strand.

Right-hand Lang's lay (RHLL) wire rope (close-up). Right-hand lay strands are laid into a right-hand lay rope.

Ordinary lay	The lay of wires in each strand is in the opposite direction to the lay of the strands that form the wire.
Lang's lay	The lay of wires in each strand is in the same direction as the lay of the strands that form the wire.
Alternate lay	The lay of wires in the strands alternate around the rope between being in the opposite and same direction to the lay of the strands that form the wire rope.
Regular lay	Alternate term for ordinary lay.
Albert's lay	Archaic term for Lang's lay.
Reverse lay	Alternate term for alternate lay.
Spring lay	This is not a term used to classify a lay as defined in this section. It refers to a specific construction type of wire rope.

Construction and specification

The specification of a wire rope type – including the number of wires per strand, the number of strands, and the lay of the rope – is documented using a commonly accepted coding system, consisting of a number of abbreviations.



Wire rope construction

This is easily demonstrated with a simple example. The rope shown in the figure "Wire rope construction" is designated thus: **6x19 FC RH OL FSWR**

6	Number of strands that make up the rope
19	Number of wires that make up each strand
FC	Fibre core
RH	Right hand lay
OL	Ordinary lay
FSWR	Flexible steel wire rope

Each of the sections of the wire rope designation described above is variable. There are therefore a large number of combinations of wire rope that can be specified in this manner. The following abbreviations are commonly used to specify a wire rope.

Abbr.	Description
FC	Fibre core
FSWR	Flexible steel wire rope

FW	Filler wire
IWR	Independent wire rope
IWRC	Independent wire rope core
J	Jute (fibre)
LH	Left hand lay
LL	Lang's lay
NR	Non-rotating
OL	Ordinary lay
RH	Right hand lay
S	Seale
SF	Seale filler wire
SW	Seale Warrington
SWL	Safe working load
TS	Triangular strand
W	Warrington
WF	Warriflex
WLL	Working load limit
WS	Warrington Seale

This image of a fraying wire rope shows some individual wires.

Terminations

The end of a wire rope tends to fray readily, and cannot be easily connected to plant and equipment. There are different ways of securing the ends of wire ropes to prevent fraying. The most common and useful type of end fitting for a wire rope is to turn the end back to form a loop. The loose end is then fixed back on the wire rope.

Right-hand ordinary lay (RHOL) wire rope terminated in a loop with a thimble and Talurit brand swaged sleeve.

Thimbles

When the wire rope is terminated with a loop, there is a risk that it will bend too tightly, especially when the loop is connected to a device that spreads the load over a relatively small area. A thimble can be installed inside the loop to preserve the natural shape of the loop, and protect the cable from pinching and abrading on the inside of the loop. The use of thimbles in loops is industry best practice. The thimble prevents the load from coming into direct contact with the wires.

Wire rope clamps/clips (aka "Crosby Clips" or "Dog Clamps")

A wire rope clamp, also called a clip, is used to fix the loose end of the loop back to the wire rope. It usually consists of a u-shaped bolt, a forged saddle and two nuts. The two layers of wire rope are placed in the u-bolt. The saddle is then fitted over the ropes on to the bolt (the saddle includes two holes to fit to the u-bolt). The nuts secure the arrangement in place. Three or more clamps are usually used to terminate a wire rope. There is an old addage which has over time become the rule; when installing the three clamps to secure the loop at the end of your wire rope make sure you do not "Saddle a Dead Horse!" The saddle portion of the clamp assembly is placed and tightened on the opposite side of the terminal end of the cable.

Swaged terminations

Swaging is a method of wire rope termination that refers to the installation technique. The purpose of swaging wire rope fittings is to connect two wire rope ends together, or to otherwise terminate one end of wire rope to something else. A mechanical or hydraulic swager is used to compress and deform the fitting, creating a permanent connection. There are many types of swaged

fittings. Threaded Studs, Ferrules, Sockets, and Sleeves a few examples.

Wedge Sockets

A wedge socket termination is useful when the fitting needs to be replaced frequently. For example, if the end of a wire rope is in a high-wear region, the rope may be periodically trimmed, requiring the termination hardware to be removed and reapplied. An example of this is on the ends of the drag ropes on a dragline. The end loop of the wire rope enters a tapered opening in the socket, wrapped around a separate component called the wedge. The arrangement is knocked in place, and load gradually eased onto the rope. As the load increases on the wire rope, the wedge become more secure, gripping the rope tighter.

Poured sockets

Used to make a high strength, permanent termination, poured sockets feature a conical cavity in line with the intended direction of strain. The end of the wire rope is inserted from the small end with the individual wires being splayed out inside the cone. The cone is then filled with molten zinc, or now more commonly, an epoxy resin compound.[1]

Eye splice

An eye splice may be used to terminate the loose end of a wire rope when forming a loop. The strands of the end of a wire rope are unwound a certain distance, and plaited back into the wire rope, forming the loop, or an eye, called an eye splice.

The ends of individual strands of this eye splice used aboard a cargo ship are served with natural fiber cord after the splicing is complete. This helps protect seaman's hands when handling.

Codes and standards

Australia

The following Australian Standards apply to wire rope:

- AS 1138-1992 Thimbles for wire rope
- AS 1394-2001 Round steel wire for ropes
- AS 1666.1-1995 Wire-rope slings - Product specification
- AS 1666.2-1995 Wire-rope slings - Care and use
- AS 2076-1996 Wire-rope grips for non-lifting applications
- AS 2759-2004 Steel wire rope - Use, operation and maintenance
- AS 3569-1989 Steel wire ropes
- AS/NZS 4812-2003 Non-destructive examination and discard criteria for wire ropes in mine winding systems

References

External links

- Wire rope and reels calculator in Deutsche, English, and Polish.
  (ie, minimum breaking load MBL, unit weight, metallic cross-section, working load limit WLL, proper reel size, etc.)
- Modern history of wire rope
- U.S. Navy Technical Manual for Wire and Fiber Rope