Wire Rope Basics - Classification & Features

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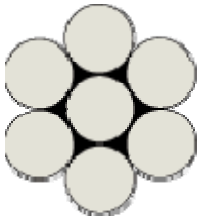
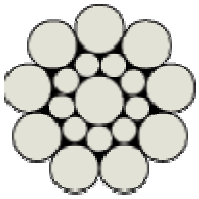
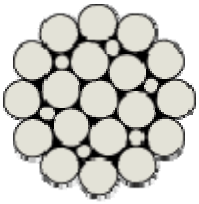
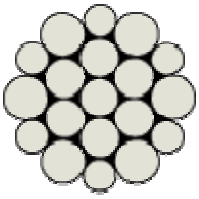
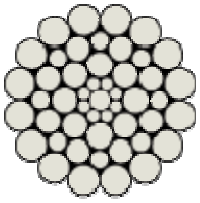
Number of strands and construction determine wire rope classification.
Wires are the basic building blocks of a wire rope. They lay around a "center" in a specified pattern in one or more layers to form a strand. The strands lay around a core to form a wire rope.


Single layer


Seale


Filler wire


Warrington


Combined Patterns

The strands provide all the tensile strength of a fiber core rope and over 90% of the strength of a wire rope with an independent wire rope core.

Characteristics like fatigue resistance and resistance to abrasion are directly affected by the design of strands.

In most strands with two or more layers of wires, inner layers support outer layers in such a manner that all wires may slide and adjust freely when the rope bends.

As a general rule, a rope that has strands made up of a few larger wires will be more abrasion resistant and less fatigue resistant than a rope of the same size made up of strands with many smaller wires. The basic strand constructions are the following:

- **Single layer:** The most common example of the single layer construction is a 7 wire strand. It has a single-wire center with six wires of the same diameter around it.
- **Seale:** This construction has two layers of wires around a center wire with the same number of wires in each layer. All wires in each layer are the same diameter. The strand is designed so that the larger outer wires rest in the valleys between the smaller inner wires.
- **Filler wire:** This construction has two layers of uniform-size wire around a center wire with the inner layer having half the number of wires as the outer layer. Small filler wires, equal in number to the inner layer, are laid in valleys of the inner layer.
- **Warrington:** This construction has two layers with one diameter of wire in the inner layer, and two diameters of wire alternating large and small in the outer layer. The larger outer-layer wires rest in the valleys, and the smaller ones on the crowns, of the inner layer.
- **Combined patterns:** When a strand is formed in a single operation using two or more of the different constructions (single layer, seale, filler wire, and / or Warrington) it is referred to as a "combined pattern." This example is a Seale construction in the first two layers. The third layer utilizes the Warrington construction, and the outer layer is a Seale construction.

(picture of Seale Warrington Seale). It is described as 49 Seale Warrington Seale [1-8-8-(8+8)-16].

Standard rope classifications

All rope of the same size, grade and core in each classification have the same minimum breaking force and weight per foot. Different constructions within each classification differ in working characteristics. Consider these features whenever you're selecting a rope for a specific application.

Classification*	Wires per strand
6x7	7 through 15
6x19	16 through 26
6x36	27 through 49
6x61	50 through 74

*Classifications are the same in 7 and 8 strand wire ropes

Special rope constructions

Unusual operating conditions often require ropes of special design to better withstand stresses or environments that would seriously impair performance of more conventional designs. Following are some of our special constructions that have been developed through WRCA's exclusive PowerSteel Technology.

- **XLT4:** "XLT" because it has Extremely Low Torque; "4" because it has the minimum breaking force of a 6-strand XXXXIP (4X) IWRC rope. What sets XLT4 apart is its unique design which packs more high tensile steel wire into the rope's diameter, giving XLT4 one of the highest strength to diameter ratios ever achieved-with a minimum breaking force 33% higher than standard 6-strand XIP ropes.

- **LoadStar:** LoadStar extended duty crane and hoist ropes were developed primarily for the container crane industry where repetitive, continuous operations are a fact of life. Subsequent research and extensive testing have shown that LoadStar delivers the same exceptional fatigue resistance and service life to other applications where bending fatigue is a problem.

- **Apex:** Over 50% stronger than standard 6-strand XIP ropes, Apex offers crane manufacturers a powerful new wire rope to optimize the performance of their equipment. Unitized construction allows each strand to nestle snuggly into the valleys of the strand below forming a dense, highly compact rope that delivers the greatest strength-to-diameter ratio of any wire rope on the market.

- **TUF-MAX®:** These shovel ropes are manufactured with an enhanced coating process that makes them more resistant to external rope wear and helps extend drum and sheave life.

WRCA specialty ropes are not limited to these products.

Rope cores

The primary function of the rope's core is to serve as the foundation for the strands - to keep the rope round and the strands properly positioned during operation. Your choice of core will have an effect upon the rope's performance. Three types of cores are most commonly used:

- **Fiber core:** polypropylene is standard, but either natural sisal (or hemp) fiber or other man-made fibers are available on special request.
- **Independent Wire Rope Core:** literally an independent wire rope with strands and a core, called IWRC. Most wire ropes made with steel core use an IWRC.
- **Strand core:** a strand made of wires. Typically strand cores are used in utility cables only.

The basic types of wire used in ropes

- **Bright wire (non-coated):** Most ropes are made with uncoated (bright) wire that is manufactured from high-carbon steel. The chemistry of the steel used and the practice employed in drawing the wire are varied to supply the ultimate combination of tensile strength, fatigue resistance and wear resistance in the finished rope.
- **Galvanized wire:** This is often used to improve corrosion resistance of wire ropes. We use the following two different procedures to manufacture galvanized wire:
    1. **Galvanized to finished size wire:** is first drawn as a bright wire to a predetermined size that's smaller than the required finished wire size. This wire is then run through the galvanizing line, and the resultant coating of zinc increases the wire diameter to the finished size. Galvanized to finished size wire has a strength 10% lower than the same size and type of bright wire. Ropes made from this wire therefore have a minimum breaking force that's 10% lower than the equivalent size and grade of bright rope.
    2. **Drawn galvanized wire:** is galvanized before the final drawing to finish size. Since the galvanized coating also goes through the drawing process, it is much thinner than the coating on galvanized to finished size wire. Drawn galvanized wires are equal in strength to the same size and type of bright wire and drawn galvanized rope is equal in strength to the same size and grade of bright rope.
    3. **Galvanized aircraft wire:** A galvanized wire that has higher tensile strength and fatigue resistance. Its primary usage is in aircraft control cables.

- **Stainless steel wire:** This is a special alloy containing approximately 18% chromium and 8% nickel. It has high resistance to many corrosive conditions and is used extensively in yachting ropes and control cables.

Wire rope grades

The most common grade of rope today is called Extra Improved Plow Steel Grade (XIP®). For most ropes, this will be the grade supplied. XIP ropes have a 15% higher minimum breaking force than Improved Plow Steel Grade (IPS), the former standard strength.

Other grades of wire rope are also available, including Extra Extra Improved Plow Grade (XXIP®). Many equipment designers are specifying XXIP grade wire rope for the operating ropes on modern higher-rated equipment. They're taking advantage of its higher minimum breaking force to help reduce total system weight. New machines can be designed with higher ratings using smaller diameter rope due to XXIP's higher strength. Minimum breaking force of XXIP grade wire rope is 10% higher than XIP grade. Ropes continue to be available in Improved Plow Steel Grade (IPS).

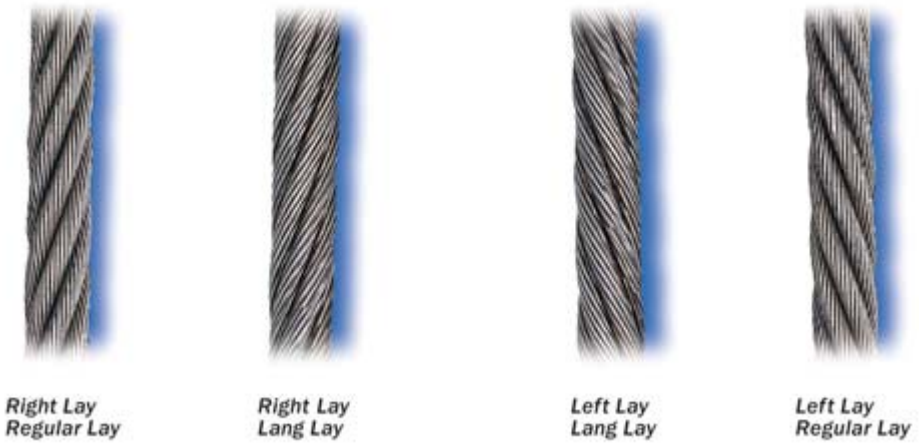
Specially-engineered wire ropes are available in higher strengths.

Preforming preshapes strands before the rope is closed

Preforming helically shapes the wires and strands into the shape they will assume in the finished rope. It improves handling and resistance to kinking by conforming the strands to the position they take in the rope.

The superior qualities of preformed ropes result from wires and strands being "at rest" in the rope, which minimizes internal stresses within the rope. Today, performing is virtually standard in rope manufacturing, and non-preformed rope is made only on special order.

Lay of a rope



The lay of a rope affects its operational characteristics. Regular lay is more stable and more resistant to crushing than lang lay. While lang lay is more fatigue resistant and abrasion resistant, use is normally limited to single layer spooling and when the rope and load are restrained from rotation. We customize the lay of our ropes to tailor them specifically to the application of the rope to maximize performance.

The first two meanings of "lay" are descriptive of the wire and strand positions in the rope. The third meaning is a length measurement used in manufacturing and inspection.

- **The DIRECTION strands lay in the rope - right or left.** When you look down a rope, strands of a right lay rope go away from you to the right. Left lay is the opposite. (It doesn't matter which direction you look.)
- **The RELATIONSHIP between the direction strands lay in the rope and the direction wires lay in the strands.** In appearance, wires in regular lay run straight down the length of the rope, and in lang lay, they appear to angle across the rope. In regular lay, wires are laid in the strand opposite the direction the strands lay in the rope. In lang lay, the wires are laid the same direction in the strand as the strands lay in the rope.

The LENGTH along the rope that a stand makes one complete spiral around the rope core. This is a measurement frequently used in wire rope inspection. Standards and regulations require removal when a certain number of broken wires per rope lay are found.