

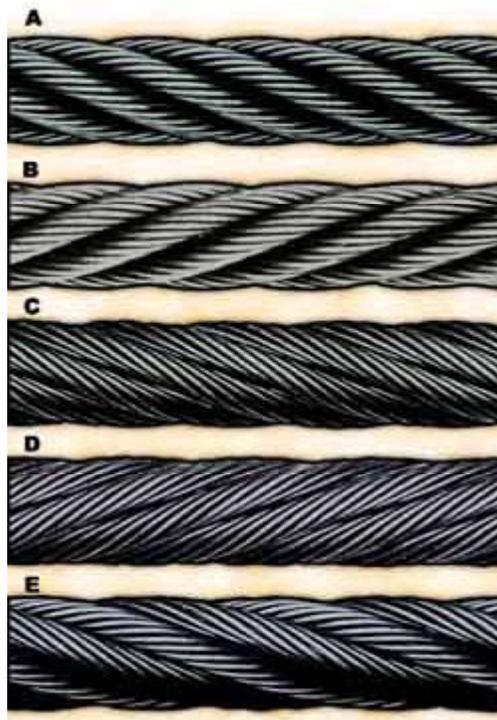


## **Lubrication Basics for Wire Ropes**

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Wire rope forms an important part of many machines and structures. It is comprised of continuous wire strands wound around a central core. There are many kinds of wire rope designed for different applications. Most of them are steel wires made into strands wound with each other. The core can be made of steel, rope or even plastics.

Wire ropes (cables) are identified by several parameters including size, grade of steel used, whether or not it is preformed, by its lay, the number of strands and the number of wires in each strand.



**Figure 1. Comparison of Typical Wire Rope Lays:**  
**A) Right Regular, B) Left Regular, C) Right Lang, D) Left Lang, E) Right Alternate**

A typical strand and wire designation is 6x19. This denotes a rope made up of six strands with 19 wires in each strand. Different strand sizes and arrangements allow for varying degrees of rope flexibility and resistance to crushing and abrasion. Small wires are better suited to being bent sharply over small sheaves (pulleys). Large outer wires are preferred when the cable will be rubbed or dragged through abrasives. There are three types of cores. An independent wire rope core (IWRC) is normally a 6x7 wire rope with a 1x7 wire strand core resulting in a 7x7 wire rope. IWRCs have a higher tensile and bending breaking strength than a fiber core rope and a high resistance to crushing and deformation.

A wire strand core (WSC) rope has a single wire strand as its core instead of a multistrand wire rope core. WSC ropes are high strength and are used mostly as static or standing ropes.

Wire ropes also have fiber cores. Fiber core ropes were traditionally made with sisal rope, but may also be made with plastic materials. The fiber core ropes have less strength than steel core ropes. Fiber core ropes are quite flexible and are used in many overhead crane applications.

The lay of a wire rope is the direction that the wire strands and the strands in the cable twist. There are four common lays: right lay, left lay, regular lay and lang lay. In a right lay rope, the strands twist to the right as it winds away from the observer. A left lay rope twists to the left. A regular lay rope has the wires in the strands twisted in the opposite direction from the strands of the cable. In a lang lay rope, the twist of the strands and the wires in the strands are both twisted the same way. Lang lay ropes are said to have better fatigue resistance due to the flatter exposure of the wires.

Wire ropes are made mostly from high carbon steel for strength, versatility, resilience and availability and for cost consideration. Wire ropes can be uncoated or galvanized. Several grades of steel are used and are described in Table 1.

**Table 1**

<b>Grade</b>	<b>Tensile Strength (psi)</b>
Extra improved plow steel	245,000 to 340,000
Improved plow steel	220,000 to 300,000
Plow steel	195,000 to 258,000
Mild plow steel	168,000 to 225,000
Iron	100,000

Steel cable wire is stiff and springy. In nonpreformed rope construction, broken or cut wires will straighten and stick out of the rope as a burr, posing a safety hazard. A preformed cable is made of wires that are shaped so that they lie naturally in their position in the strand, preventing the wires from protruding and potentially causing injury. Preformed wire ropes also have better fatigue resistance than nonpreformed ropes and are ideal for working over small sheaves and around sharp angles.

### **Wire Rope Lubrication**

Lubricating wire ropes is a difficult proposition, regardless of the construction and composition.

Ropes with fiber cores are somewhat easier to lubricate than those made exclusively from steel materials. For this reason, it is important to consider carefully the issue of field relubrication when selecting rope for an application.

Wire rope lubricants have two principal functions:

1. To reduce friction as the individual wires move over each other.
2. To provide corrosion protection and lubrication in the core and inside wires, and on the exterior surfaces.

There are two types of wire rope lubricants, penetrating and coating. Penetrating lubricants contain a petroleum solvent that carries the lubricant into the core of the wire rope then evaporates, leaving behind a heavy lubricating film to protect and lubricate each strand (Figure 2). Coating lubricants penetrate slightly, sealing the outside of the cable from moisture and reducing wear and fretting corrosion from contact with external bodies.



**Figure 2. Foam Penetrating Type Wire Rope**

Both types of wire rope lubricants are used. However, because most wire ropes fail from the inside, it is important to make sure that the center core receives sufficient lubricant. A combination approach in which a penetrating lubricant is used to saturate the core, followed with a coating to seal and protect the outer surface, is recommended. Wire rope lubricants can be petrolatum, asphaltic, grease, petroleum oils or vegetable oil-based (Figure 3).



**Figure 3. Grease Lubed Wire Rope**

Petrolatum compounds, with the proper additives, provide excellent corrosion and water resistance. In addition, petrolatum compounds are translucent, allowing the technician to perform visible inspection. Petrolatum lubricants can drip off at higher temperatures but maintain their consistency well under cold temperature conditions.

Asphaltic compounds generally dry to a very dark hardened surface, which makes inspection difficult. They adhere well for extended long-term storage but will crack and become brittle in cold climates. Asphaltics are the coating type.

Various types of greases are used for wire rope lubrication. These coating types penetrate partially but usually do not saturate the rope core. Common grease thickeners include sodium, lithium, lithium complex and aluminum complex soaps. Greases used for this application generally have a soft semifluid consistency. They coat and achieve partial penetration if applied with pressure lubricators.

Petroleum and vegetable oils penetrate best and are the easiest to apply because proper additive design of these penetrating types gives them excellent wear and corrosion resistance. The fluid property of oil type lubricants helps to wash the rope to remove abrasive external contaminants.

Wire ropes are lubricated during the manufacturing process. If the rope has a fiber core center, the fiber will be lubricated with a mineral oil or petrolatum type lubricant. The core will absorb the lubricant and function as a reservoir for prolonged lubrication while in service.

If the rope has a steel core, the lubricant (both oil and grease type) is pumped in a stream just ahead of the die that twists the wires into a strand. This allows complete coverage of all wires.

After the cable is put into service, relubrication is required due to loss of the original lubricant from loading, bending and stretching of the cable. The fiber core cables dry out over time due to heat from evaporation, and often absorb moisture. Field relubrication is necessary to minimize corrosion, protect and preserve the rope core and wires, and thus extend the service life of the wire rope.

If a cable is dirty or has accumulated layers of hardened lubricant or other contaminants, it must be cleaned with a wire brush and petroleum solvent, compressed air or steam cleaner before relubrication. The wire rope must then be dried and lubricated immediately to prevent rusting. Field lubricants can be applied by spray, brush, dip, drip or pressure boot. Lubricants are best applied at a drum or sheave where the rope strands have a tendency to separate slightly due to bending to facilitate maximum penetration to the core. If a pressure boot application is used, the lubricant is applied to the rope under slight tension in a straight condition. Excessive lubricant application should be avoided to prevent safety hazards.

### **Key Lubricant Performance Measures**

Some key performance attributes to look for in a wire rope lubricant are wear resistance and corrosion prevention. Some useful performance benchmarks include high four-ball EP test values, such as a weld point (ASTM D2783) of above 350 kg and a load wear index of above 50. For corrosion protection, look for wire rope lubricants with salt spray (ASTM B117) resistance values above 60 hours and humidity cabinet (ASTM D1748) values of more than 60 days. Most manufacturers provide this type of data on product data sheets.

### **Factors that Influence Wire Rope and Cable Performance**

Cable life cycle and performance are influenced by several factors, including type of operation, care and environment. Cables can be damaged by worn sheaves, improper winding and splicing practices, and improper storage. High stress loading, shock loading, jerking heavy loads or rapid acceleration or deceleration (speed of the cable stopping and starting) will accelerate the wear rate.

Corrosion can cause shortened rope life due to metal loss, pitting and stress risers from pitting. If a machine is to be shut down for an extended period, the cables should be removed, cleaned, lubricated and properly stored. In service, corrosion and oxidation are caused by fumes, acids, salt brines, sulfur, gases, salt air, humidity and are accelerated by elevated temperatures. Proper and adequate lubricant application in the field can reduce corrosive attack of the cable.

Abrasive wear occurs on the inside and outside of wire ropes. Individual strands inside the rope move and rub against one another during normal operation, creating internal two-body abrasive wear. The outside of the cable accumulates dirt and contaminants from sheaves and drums. This causes three-body abrasive wear, which erodes the outer wires and strands. Abrasive wear usually reduces rope diameter and can result in core failure and internal wire breakage. Penetrating wire rope lubricants reduce abrasive wear inside the rope and wash off the external surfaces to remove contaminants and dirt.

### Typical Rope Applications

Many types of machines and structures use wire ropes, including draglines, cranes, elevators, shovels, drilling rigs, suspension bridges and cable-stayed towers. Each application has specific needs for the type and size of wire rope required. All wire ropes, regardless of the application, will perform at a higher level, last longer and provide greater user benefits when properly maintained.

Through years of field experience, Lubrication Engineers has found that longer wire rope life can be obtained by using penetrating lubricants, either alone or when used in conjunction with a coating lubricant. Practical experience at a South African mine suggests that life cycles may be doubled with this approach. At one mine site, the replacement rate for four 44-mm ropes was extended from an average 18.5 months to 43 months. At another mine, life cycles of four 43-mm x 2073 meter ropes were extended from an average 8 months to 12 months.

In another study involving 5-ton and 10-ton overhead cranes in the United States that used 3/8-inch and 5/8-inch diameter ropes, the average life of the ropes was doubled. The author attributes this increased performance to the ability of the penetrating lubricant to displace water and contaminants while replacing them with oil, which reduces the wear and corrosion occurring throughout the rope. A good spray with penetrating wire rope lubricant effectively acts as an oil change for wire ropes.

In these examples, the savings in wire rope replacement costs (downtime, labor and capital costs) were substantial and dwarfed the cost of the lubricants. Companies who have realized the importance of proper wire rope lubrication have gained a huge advantage over those who purchase the lowest priced lubricant, or no lubricant at all, while replacing ropes on a much more frequent basis.

### About Lubrication Engineers

A leader in lubricants since 1951, Lubrication Engineers, Inc., manufactures and markets premium lubricants formulated from highly refined base oils. Enhanced with proprietary additives, LE oils and greases provide unmatched performance in nearly any application operating in normal-to-severe conditions. All Lubrication Engineers® lubricants are manufactured in an ISO 9001:2000 certified quality system at LE's state-of-the-art plant in Wichita, Kan., and are available worldwide. With its comprehensive offering of lubricants and related reliability products, LE provides its customers with increased profitability through longer equipment life, extended service intervals, reduction in energy use, fewer repairs and less need for inventory.

### References

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