Wire rope forms a highly important part of many machines and structures. Generally speaking, wire rope is comprised of continuous wire strands wound around a central core. There are many kinds of wire rope designed for many 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 stand.

A typical strand and wire designation is 6x19. This denotes a rope made up of six strands with 19 wires in each strand. Different types of strand sizes and arrangements allow for varying flexibility and resistance to crushing and to abrasion. Small wires are better when the rope is bent sharply over small sheaves (pulleys). Large outer wires are best when the cable will be rubbed or dragged through the dirt.

The core of wire ropes is the central member that supports the strands wrapped around it. There are three general 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. IWRC’s have a higher breaking strength than a fiber core rope and a high resistance to crushing and deformation. Lubrication while in service is somewhat difficult due to this type of construction.

A wire strand core (WSC) rope has a single wire strand as the core instead of a multi-strand wire rope core. WSC ropes are high strength and are mostly used as static or standing ropes. Field lubrication is usually difficult. As such, the application should be carefully considered to allow for adequate effective relubrication. Wire ropes also commonly have fiber cores. Fiber core ropes formerly were made with sisal rope, however today many use 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. Lubrication of fiber core ropes is somewhat easier since the fiber core (sisal) absorbs the lubricant and serves as a reservoir.

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 obscurer. A left lay 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 mostly made from high carbon steel for strength, versatility, resilience, availability and lower cost. Wire ropes can be uncoated or galvanized. Several grades of steel are used and are described in the following table.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Tensile Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra Improved Plow Steel</td>
<td>245,000-340,000</td>
</tr>
<tr>
<td>Improved Plow Steel</td>
<td>220,000-300,000</td>
</tr>
<tr>
<td>Plow Steel</td>
<td>195,000-258,000</td>
</tr>
<tr>
<td>Mild Plow Steel</td>
<td>168,000-225,000</td>
</tr>
<tr>
<td>Iron</td>
<td>100,000</td>
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</tbody>
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Steel cable wire is very stiff and springy. In non-performed rope construction broken or cut wires will straighten and stick out of the rope as a burr causing a safety concern. A preformed cable is made of wires that are shaped so that they lie naturally in their position in the strand and don’t pop out and cause injury to hands. Preformed wire ropes also resist fatigue better and are better for working over small sheaves and around sharp angles.

Wire rope lubricants have three 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.
3. To provide corrosion protection on the exterior surfaces.

Internal wear and internal corrosion can be caused by loss of lubricant and corrosion protection, by lubricant degradation by products and by fretting due to movement between the wires. External factors that should be considered when choosing a wire rope lubricant are mainly those relating to the operating environment in which the rope is used. These include rain, salt spray, high ambient temperatures, low ambient temperatures, acids, strong bases, abrasive contaminates, and wearing actions on the sheaves, drums and machinery.

There are two basic types of wire rope lubricants; Penetrating and Coating. Penetrating type lubricants contain a petroleum solvent that carries the lubricant into the core of the wire rope then evaporates leaving a heavier lubricant oil behind to protect and lubricate each strand. Coating wire rope lubricants penetrate slightly while sealing the outside of the cable from moisture and to reduce wear and fretting corrosion. While both types of wire rope lubricants are used, it seems more important to use a penetrating wire rope lubricant since most wire ropes fail from the inside out. A combination approach is best to allow a penetrating lubricant to saturate the core and followed with a coating type to seal and protect the outer surface.

The common types of lubricants used are petrolatum, asphaltic, grease, petroleum oils, and vegetable oils. Petrolatum compounds, with the proper additives, provide excellent corrosion and water resistance. They are translucent which allows visibility for inspection. If temperatures are too high petrolatum could drip. At low temperatures they resist cracking.

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.

Many types of greases are used for wire rope lubrication. Thickener types that are common are sodium, lithium, lithium complex, and aluminum complex soaps. Greases generally are soft semi-fluid consistency that coat with partial penetration if applied with pressure lubricators.

Petroleum and vegetable oils penetrate best and are most easily applied. Proper additive design gives them excellent wear and corrosion resistance. Fluid oil wire rope lubricants also “wash” the rope to remove abrasive external contaminates. Generally, transparent oils allow for easy inspection of the wire rope.

During the manufacturing process, lubricant is applied to wire ropes. If a fiber core is used, careful attention is given to it since it is a reservoir for future and continuous lubricant storage. Typical core lubricants are mineral oil and petrolatum.

Steel cores are lubricated with the same thing as the rest of the cable. Lubricant is pumped in a stream just ahead of the die that twists the wires into a strand. This allows complete coverage of all wires.

In field service relubrication is required due to loss of original lubricant from loading, bending, and stretching of the cable. Also, fiber cores tend to dry out over time due to heat. When dry, the fiber core will tend to absorb moisture. Field relubrication is necessary to minimize internal corrosion, protect and preserve the rope core, and to extend the service life of the wire rope.

If cables are dirty or have accumulated layers of hardened
lubricant or other contaminants, they must be cleaned before relubrication with a wire brush and petroleum solvent, compressed air, or steam cleaner. The wire rope must be dried and lubricated right away to prevent rusting. Field lubricants can be applied by spray, brush, dip, drip or pressure boot. The lubricants used in field relubrication include petroleum, mineral oils, greases, and solvent cut back asphaltics. Lubricants should be designed to penetrate into the core of the wire rope and are best applied at a drum or sheave where the rope strands have a tendency to separate slightly due to bending. If a pressure boot application is used it can placed on straight pulled rope. Excess lubricant quantities should be avoided to prevent safety hazards.

The life to failure and performance of wire rope is reduced by many factors of operation, care, and environment. Cables can be abused by wornout sheaves, bad winding practices, bad splicing and improper storage. Neglecting to properly field relubricate a wire rope will also reduce the service life. High stress loading from shock or jerking up loads or rapid acceleration or deceleration will wear on the fatigue life of the cable. These types of failures are cumulative over time.

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 a long time the cables should be removed, cleaned, lubricated, and stored properly. In service, corrosion is caused by fumes, acids, salt brines, sulfur, gases, salt air, humidity and temperature. 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. The inside of the rope moves one wire, one strand against the other causing abrasive rubbing that must be lubricated to achieve long rope life. The outside of the cable gets abrasive dirt (drag rope) and also contaminates from sheaves and drums, which wear away the outer wires and strands. Abrasive wear usually causes rope diameter to be reduced and can result in core failure and internal wire breakage. Penetrating wire rope lubricants reduce abrasive wear inside the rope and also “wash off” the external surfaces to remove contaminates and dirt.

Many types of machines and structures use wire ropes. These include drag lines, 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, no matter what the application, will perform at a higher level, last longer, and provide greater user benefits when properly cared for with the needed lubrication with proper lubricants at manufacture and during field relubrication. Field relubrication is most important to maintain the integrity and safety of the wire rope and to prevent shortened life or safety hazards.

Some of the key performance attributes to look for in a wire rope lubricant are wear and corrosion prevention. For wear protection, look for wire rope lubricants with high values for Four-Ball EP (ASTM D-2783) such as a Weld Point of over 350 kg and a Load Wear Index of over 50. For corrosion protection, look for wire rope lubricants with a Salt Spray (ASTM B-117) test result of over 60 hours and a Humidity Cabinet (ASTM D-1748) of over 60 days. These are very useful benchmarks for comparing the products available from different manufacturers, in order to select a product with the best possible performance. This information should be on their technical data sheets unless they are hiding something.

Lubrication Engineers have found, through years of field experience, that longer wire rope life can be obtained through the use of penetrating type wire rope lubricants, both when used alone and when used in conjunction with a coating type wire rope lubricant. The wire rope life is typically doubled in this manner. For example, in gold mines in South Africa, at one mine four 44mm ropes had their lives extended from an average 18.5 months to 43 months, while at another mine the life of four 43mm x 2073 m ropes were prolonged from an average 8 months to 12 months. In another study, 5 to 10 ton overhead cranes in the US, using 3/8” and 5/8” diameter wire ropes, saw the life of the rope more than double. The increased performance is attributed to the ability of the penetrating lubricant to displace water and contaminants while replacing them with oil, which reduces the wear and corrosion throughout the rope. A good spray with penetrating type wire rope lubricant is essentially an oil change for wire ropes.

In these and countless other cases, 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 competitive advantage over competitors who are still purchasing the lowest priced lubricant, or no lubricant at all, and replacing their ropes on a much more frequent basis.

References
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CRC Press, Inc. Copyright 1983. Pages 193-201
Effective Lubrication, Allen F. Brewer, Copyright 1974
Krieger Publishing Co. Pages 236-242
Penetrating Wear and Corrosion Preventative For Wire Ropes and Chains

Many customers have benefited from the use of LE’s 2001 MONOLEC® Wire Rope Lubricant. Industries like Paving, Sand & Gravel, Sugar Beet Processors, Road Construction, Electric Co-op Services and Mining Operations of all kinds have greatly benefited from LE’s 2001 as a wire rope lubricant, chains lubricant and penetrating-type oil.

Paving—Paving operators like LE’s 2001 for its ability to lubricate chain drives on paving rollers and hot plants. It is a penetrating type lubricant providing superior load carrying capacity and corrosion resistance. It contains petroleum solvent to enhance penetration to the core. When solvent evaporates a thin film of heavy-bodied oil remains to protect and lubricate each strand. LE’s 2001 contains MONOLEC®, LE’s exclusive wear-reducing additive.

Sand & Gravel—Crushing Crews particularly like LE’s 2001 for the chains on jaw crushers.

Sugar Beet Processor—use large chain driven beet pilers to stack their beets for transportation. The large chains on these machines are exposed to the elements. In addition, mud is always a potential problem as it slings off the conveyor system onto the chains. LE’s 2001 penetrates quickly into the pin and will not squeeze out like other products. This penetration also keeps the product from forming a sticky surface that the mud can cling to. Operators believe that this helps to increase chain life. LE’s 2001 is also available in aerosol cans or can be applied with weed-type sprayers with solvent-type nozzles.

Road Construction—Bridge Building Crews like LE’s 2001 for cranes. It has the ability to lubricate chains and especially their wire ropes. Typically the only chance to lubricate the wire rope on the cranes is late fall or winter. The product’s ability to penetrate provides excellent rust preventative benefits to the operator. Fretting of the rope is also drastically reduced.

Electric Co-op—They typically operate pole trucks that have chain drives. The work is dirty and LE’s 2001 does not buildup on the chain, but does penetrate into the pin. This keeps a high oil film strength of protection in the pin; keeping contaminants like dust, dirt, water, etc. out of the chain.

Mining—LE’s 2001 is an excellent hoist cable lubricant and forklift chain lubricant.

Benefits of LE’s 2001 MONOLEC® Wire Rope Lubricant:

- Penetrates better
- Delivers an EP oil into the pin which greatly reduces wear and rope fretting
- Self cleaning—buildup is greatly lowered by the product’s penetration capabilities and the fact that reapplying the product cuts off potential product buildup or other contaminants that may attach themselves to the chain
- Excellent rust preventative