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# SAFE USE OF FIBER AND WIRE ROPES

Understand their conditions, concerns, and care.

Fiber rope and wire rope are widely used across the groundwater industry. Fiber rope is more commonly used in manual hoisting, such as raising up or lowering down tools. Wire rope is commonly used for mechanical hoisting operations.

The improper use of fiber rope or wire rope can result in serious incidents involving property damage, injuries, and death. Using the ropes as intended within their safe working load and maintaining them in good condition are critical in preventing rope failures.

Both types of rope include a combination of characteristics that give them certain performance traits depending on design, materials, and composition.

## Wire Rope Construction

Wire rope is made of steel wires laid together to form a strand. These strands are laid together to form a rope, usually around a central core of either fiber or wire.

The number of strands, number of wires per strand, type of material, and nature of the core depend on the intended purpose of the wire rope. Wire rope that has many smaller wires and strands is more flexible than rope with larger-diameter wires and fewer strands. Wire rope used with sheaves and drums should have many strands to be flexible enough to bend around the sheaves and drums.

Wire ropes are classified by grouping the strands according to the number of wires per strand. The number of wires and the pattern defines the rope's characteristics.

For example, a 6 × 7 rope indicates the rope is comprised of six strands and each individual strand is comprised of seven wires. This particular rope has large wires and is not very flexible but has good abrasion-resistant qualities. Whereas, a 6 × 19 rope has 19 wires per strand and thus is more flexible.

The more wires in a strand, the more flexible the wire rope. Likewise, the more strands in the rope, the more flexible the rope. However, the more strands in a rope and more wires in a strand, the less abrasion resistant.

Other important requirements to consider when selecting a wire rope are the breaking strength and "safe working load." These values can be found with the use of a chart.

Most hoisting jobs use a safe working load based on a 5:1 safety factor of the wire rope's breaking strength. However, this safety factor should be even higher if there is a possibility of injury or death from the rope breaking. For example, elevators are based on a 20:1 safety factor. Critical lifts with a danger to personnel should be calculated on a 10:1 safety factor.

## Wire Rope Inspection

Wire rope inspections are important checks on any type of rigging equipment. Wear, metal fatigue, abrasion, corrosion, kinks, and improper reeving are more important in dictating the life of a wire rope—more so than its breaking strength when new. Therefore, wire rope should be regularly inspected in accordance with OSHA and industry standards.

The frequency of inspections depends on the service conditions. Slings should be inspected each day before being used. Wire rope in continuous service or severe conditions should be inspected at least weekly and also observed during normal operation. For most other applications, wire rope should be inspected at least monthly.

Wire rope should be inspected for the following conditions:

**Broken wires:** Removing a wire rope from service due to broken wires depends on how the particular rope is being used. Finding one broken wire (or several widely spread) is usually not a problem. Regular breaks are a cause for concern and require a closer inspection. General guidelines for rope replacement due to broken wires are as follows:

*Running wire ropes:* Six randomly distributed broken wires in one rope lay or three broken wires in one strand in one rope lay, where a rope lay is the length along the rope in which one strand makes a complete revolution around the rope.

*Pendants or standing wire ropes:* More than two broken wires in one rope lay located in the rope beyond end connections or more than one broken wire in a rope lay located at an end connection.

*Slings:* Ten randomly distributed broken wires in one rope lay or five broken wires in one strand in one rope lay.

*Rotation-resistant ropes:* Two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters.

*Valley breaks:* Wire ropes with any wire breaks in between two adjoining strands should be removed from service.

**Abrasion:** Wire rope winding over drums or through sheaves will wear. The rope should be replaced if the outer wire exceeds one-third of the original diameter.

**Crushed strands:** This condition is a result of too many layers of rope wrapped around a drum. There should be no more than two layers of wire rope on the drum, especially if the rope is a type with many small wires (such as 6 × 37). Crushing also occurs by cross winding, which is a result of poor winding procedures when the rope is wound in a pile in the middle of a drum.

**Corrosion:** This problem is difficult to evaluate and is also much more serious than normal wear. Corrosion will often start inside the rope before it shows on the outside. A lack of lubrication is usually the cause. Wire pitting or severe rusting should be cause for immediate replacement.

**Kinks:** Kinks are permanent distortions. After a wire rope is kinked, it is impossible to straighten the rope enough to return it to its original strength. If a rope cannot be unkinked by hand, it should be removed from service.

**Electric arc:** Wire rope that has been inadvertently (or purposely) used as a ground in welding or has been in contact with a live power line will have fused or annealed wires, and must be removed from service.

**Metal fatigue:** This is usually caused by bending stress from repeated passes over sheaves, or from vibration such as crane pendants. Fatigue fractures can be external or internal. A larger sheave or drum size, or using a more flexible rope, may increase the rope life.

**Diameter reduction:** Any noticeable reduction in diameter is a serious deterioration problem. A wire rope is measured across its diameter at its widest point. Diameter reduction could be caused by one fault or a combination of faults. Wire ropes should be replaced when the reduction in diameter is more than 5% from the nominal diameter.

**Wire rope stretch:** Any new wire rope will stretch when the initial load is applied. After the initial stretch and a slight stretching over time during normal wear, the rope will begin to stretch at a quicker rate, which means it is approaching time for replacement.

**Bird caging:** This is a torsional imbalance, which is a result of mistreatment such as pulling rope through tight sheaves, being wound on too small a drum, or sudden stops.

**Scrubbing:** This is a wearing or displacement of wires resulting from rubbing against something.

**Protruding core:** Any rope damage resulting in a spreading of the strands with the core bulging out means the rope should be replaced.

A wire rope is lubricated during the manufacturing process. This provides the rope with protection for a reasonable time if stored under proper conditions. When the wire rope is in service, the initial lubrication will not be enough to last the lifetime of the rope. Therefore, it is usually necessary to apply a lubricant to a wire rope under working conditions. A light mineral oil can be used for lubrication. Never use old crankcase oil.

## Fiber Rope

Fiber ropes are preferred for some rigging applications because they are more pliant. However, they should be used only on light loads and must not be used on objects that have sharp edges capable of cutting the rope. Fiber ropes should also not be used where they will be exposed to high temperatures, severe abrasion, or acids.

The choice of rope depends on its application. Manila is a natural fiber and has relatively high elasticity, strength, and resistance to wear and deterioration. Manila rope is generally the most common natural fiber rope used because of its quality and relative strength.

The principal synthetic fiber used for rope is nylon, which has a tensile strength nearly three times that of manila. The advantages of nylon rope are it is waterproof and has the ability to stretch, absorb shocks, and resume its normal length. Nylon also has better resistance against abrasion, rot, decay, and fungus growth as compared to natural fibers.

The strength and useful life of fiber rope is shortened considerably by improper care. To prolong the life and strength of the rope:

- Make sure the rope is kept dry. Store in a cool, dry place to reduce the chances of mildew and rotting.
- Coil rope on a spool or hang it from pegs in a way that will allow the circulation of air.
- Avoid dragging rope through sand or dirt or pulling over sharp edges. Sand or grit between the fibers of the rope cuts the fibers and reduces its strength.
- Slacken taut lines before they are exposed to rain or dampness because a wet rope shrinks and may break.
- Thaw a frozen rope completely before using it; otherwise, the frozen fibers will break as they resist bending.
- Avoid exposing rope to excessive heat and chemical fumes. Heat or boiling water decreases rope strength by 20%.

The outside appearance of fiber rope is not a good indication of its internal condition. The rope softens with use. Dampness, heavy strain, fraying and breaking of strands, and chafing on rough edges all weaken the rope considerably.

Overloading a rope may cause it to break. For this reason, fiber ropes should be inspected at regular intervals to determine their condition. Untwist the strands slightly to open the rope so the inside can be examined.

Mildewed rope has a musty odor and the inner fibers of the strands have a dark, stained appearance. Broken strands or broken yarns ordinarily are easy to identify. Dirt and sawdust-like material inside the rope, caused by chafing, indicate damage. In rope having a central core, the core should not break

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### DACUM Codes

To help meet your professional needs, this article covers skills and competencies found in DACUM charts for drillers and pump installers. DO refers to the drilling chart. The letter and number immediately following is the skill on the chart covered by the article. This article covers:

**DOB-3, DOD-1, DOD-6, DOE-1, DOK-10**

More information on DACUM and the charts are available at *www.NGWA.org*.

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away in small pieces upon examination. If this happens, it indicates the rope has been overstrained.

Natural and synthetic fiber rope slings should be immediately removed from service if any of the following conditions are present:

- Abnormal wear
- Powdered fiber between strands
- Broken or cut fibers
- Variations in the size or roundness of strands
- Discoloration or rotting
- Distortion of hardware in the sling.

When any unsatisfactory conditions are found, destroy the rope or cut it up in short pieces to prevent it from being used in hoisting applications.

To prevent rope failures and minimize deterioration and damage: select the right rope for the job, inspect regularly, use as intended, and properly store and maintain. WWJ

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