

4 - Inspecting Wire Rope, Sheaves and Drums

Regular inspection is an essential part of any wire rope peak performance program. Catching a problem in its early stages of development allows you to adjust operating practices and prevent potentially dangerous breaks while the rope is under load.

Inspecting a rope, especially for the first time, begins with good preparation, as outlined in the steps below.

1. Gather your inspection tools and supplies. For a complete inspection of the rope, sheaves, drums and end attachments, you'll need (Figure 13):

- an inspection log
- a caliper
- a tape measure
- sheave and drum groove gauges
- chalk
- cleaning cloths
- carbon paper and clean white paper
- a pen and pencil
- leather gloves

2. Identify the rope. Before you can know what to look for in your inspection, you have to know something about the rope. Begin by identifying its diameter and construction. Note that all measurements of a rope's diameter must be performed at the widest point, as shown in Figure 14.

2a. Measure the rope diameter. To get an accurate dimension, measure three times at the

same location. On a six-strand rope, for example, you'll measure all three diameters, i.e. the distance between the outsides of strands 1 and 4, 2 and 5, and 3 and 6, as shown in Figure 14. On an eight-strand rope you may want to measure all four diameters.

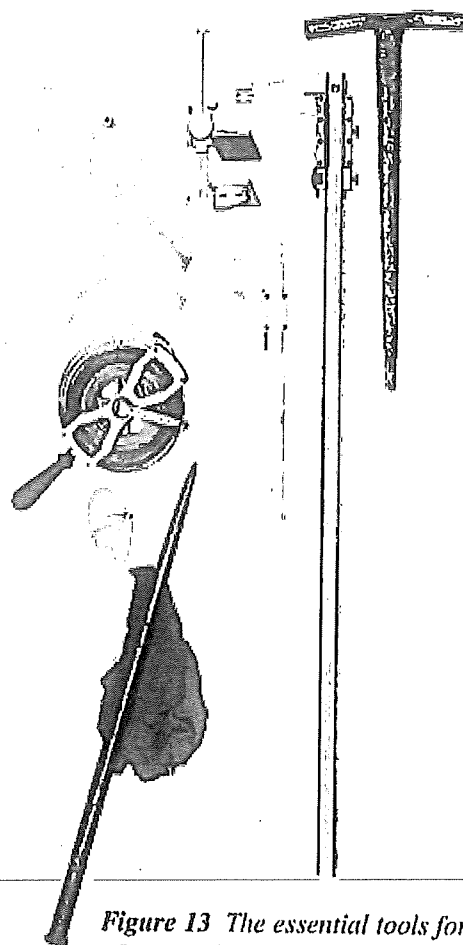


Figure 13 The essential tools for inspection of ropes, sheaves, drums and attachments.

Repeat these measurements at several locations on the rope, especially at the pick-up points, in areas of heavy wear, and in areas close to the end attachments. Record them in the inspection log.

2b. Compare your measurements with the rope's catalog or nominal diameter.

Keep in mind that all manufacturers make their ropes with diameters larger than their nominal listings. This is to allow for the initial "pull down" of the diameter when new, unused rope is placed under load for the first time and the wires "seat in."

Note that there is no industry standard for the difference between nominal and manufactured diameter sizes. For specifics, check with the individual manufacturer.

A change in diameter can be a warning sign of potential or actual failure, so it must be measured during every inspection. A new rope's initial measurement should be taken after it has had a chance to seat in. The initial measurement is then used as a reference for future comparisons.

A gradual decrease in diameter is to be expected over time, but a sudden decrease, especially a large one, may be a sign of a broken core.

2c. Identify the rope's construction. This is done by making a physical count of the rope's strands and wires per strand. The rope manufacturer's test certificate should simplify the task. Just be sure the rope matches what is on the certificate.

Note that manufacturers do not always supply test certificates, and those who do usually do so only by special request.

3. Verify the rope's breaking strength.

Again, this can be done by checking the manufacturer's test certification. Remember, there is a difference between static breaking strength and dynamic breaking strength and, in most cases, the test certification will be based on a quasi-static test. If you're not sure, check with your supplier.

4. Review the retirement criteria and verify the design factor.

The design factor is a ratio of a rope's nominal or catalog strength to the rated load of the application intended. Multiplying this rated load by the design factor provides the minimum catalog strength of the rope required for the application.

$$\text{Rated Load} \times \text{Design Factor} = \text{Minimum Catalog Strength}$$

Most ropes designed for surface mining applications employ a design factor of 5.0. Using this design factor, a rated load for the application of 80 tons (81.3 tonnes), requires a rope with a minimum catalog strength of 400 tons (406 tonnes), calculated as 80×5 (81.3×5). Always consult the manufacturer when a rope of a different catalog strength is intended to be used.

5. Review the rope's inspection history.

This can be a big time and money saver, but only if the records are accurate and up to date. The inspection history can provide valuable clues as to

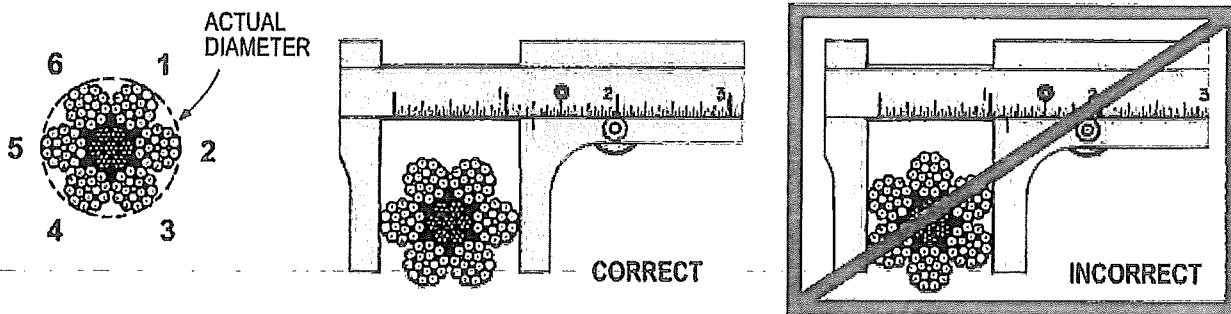


Figure 14 The correct way to measure a rope's diameter is across the widest point, from crown to crown of opposite strands, not from valley to valley.

the cause and remedy of rope problems. If the inspection log indicates rope removal due to localized damage in a particular area, inspect that area first.

Inspection Methods

There are many different methods and procedures used to inspect wire rope used on mining equipment. These can and do vary from mine to mine, the type of equipment at the mine, the functional application of the wire rope and the specific safety standards and requirements enacted at the particular mine site. Thus the responsibility for defining and implementing inspection procedures rests with the management of each individual mine, the specifics of which cannot be addressed here.

Rope Retirement Criteria

Using a rope beyond its useful life is a dangerous practice that can put people's lives in jeopardy. Any cost savings gained by delaying rope replacement can be lost quickly if the rope breaks during operation and causes bodily injury or damage to the machine.

Always replace wire rope according to the equipment manufacturer's or wire rope manufacturer's specifications for the application. Follow the specifications for length, diameter, class of construction, breaking force, and type of rope attachments or terminations. Maintaining 2-1/2 to 3 wraps of rope on the drum for all authorized working conditions determines the shortest length.

Note: Physical dimensions of the outer geometry of rope attachments can vary from one manufacturer to another. Do not order ropes with attachments from suppliers other than the original equipment manufacturer without first verifying it will fit into the physical opening and permit the normal range of movement after installation.

No precise rules can be given for determination of the exact time for replacement of wire rope and strand since many variable factors are involved.

Some variables include:

- number of hours in service
- type of application (how the rope is used)
- the loads applied to it, and their frequency
- frequency of lubrication, or no lubrication
- effect of corrosive environment

A shorter working life of rope and strand will result from lack of maintenance. The remaining strength and safety of a wire rope or strand in continued use is determined by both careful inspection for signs of deterioration, and the judgement of an authorized, qualified person.

Note: Discard criteria will vary based on the application; for example, hoist ropes versus drag ropes.

Use the following basic criteria when evaluating the condition (strength and safety) of wire rope and strand. If any doubt exists about the remaining useful life of a wire rope or strand **it should be removed from service!**

Running Rope Retirement Criteria

- Six randomly distributed broken wires in one lay length, or three broken wires in one strand in one lay. Six wires broken at the drag rope socket (in this case, the rope could be shortened and re-socketed).

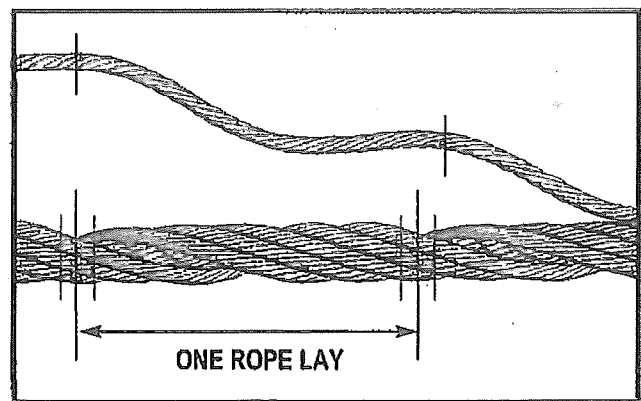


Figure 15 The length of one rope lay is the distance required for a single wire to make one complete helical convolution about the rope's core.



Wire Rope Inspection Checklist

<i>Problem</i>	<i>Probable Cause</i>
Rope broken square-off	Overload or localized wear. If overload is sudden, it will cause a square-off break.
One or more strands broken	Overloading, kinking, damage or localized wear weakening one or more strands.
Undue corrosion	Lack of proper lubrication. Exposure to salt or alkaline water. Idle periods.
Protruding rope core	Shock loading.
Ropes damaged in transit to location	Rolling the reel over an obstruction or dropping from the truck onto any hard surface results in rope distortion or damage. Use of chains for lashing or use of a lever against the rope.
Ropes show kinks, dog legs, or other types of distortion	Result of improper handling, installation or operating abuse.
Ropes show excessive wear in spots	Kinks or bends in rope due to improper handling during installation or service. Repetitive contact point causing severe localized wear.
Ropes damaged by irregular or improper winding on drums	Excessive fleet angle or lack of attention when rope is installed. Worn grooves, worn flanges, lack of a level wind system.
Unequal pressure and distortion of wires and rope	Damage due to scraping of rope over sharp surface or because of improperly fitted clamps or clips.
Side wear on rope	Ropes operated over damaged sheaves or drums or improperly aligned equipment. Drum groove too deep for fleet angle of rope.
Fatigue breaks in wire	Severe bending. Possibly due to excessive vibration, or due to poor operating conditions.
Spiraling or curling	Allowing rope to drag or rub over any small radius bend.
Ropes show excessive flattening or crushing	Overloading or poor spooling.

Note: The number of wire breaks that cannot be accepted varies with rope usage and construction. For general applications, this six-and-three criteria is satisfactory. Common practice by mine operators for draglines is to use this criteria for hoist ropes only.

- One outer wire broken at the contact point with the core of the rope which has worked its way out of the rope structure and protrudes or loops out from the rope structure.
- Wear of one-third the original diameter of outside individual wires from abrasion.
- Kinking, crushing, cutting, birdcaging, unstranding or any other damage resulting in distortion of the rope structure.
- Evidence of any heat damage from any cause including an electric arc.
- Protruding core (from an opening between strands).
- Valley breaks - when two or more wire fractures are found.
- Severe corrosion particularly in the vicinity of end attachments.
- Reductions from nominal rope diameter of more than 10% of a new rope after installation, or an observable increase in rope lay length.

Rope Pendant Retirement Criteria

- More than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.
- Loose or damaged strands.

Standing Rope Retirement Criteria

- More than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.
- Loose or damaged strands

Note: Where possible, ropes should be rotated out of sheave contact areas for inspection.

Strand Pendant Retirement Criteria

- Visible or sounding breaks in 25% of the outer wires or 10% of the total, whichever is less; or 10% loss of strength based on size and load capacity of each broken wire.
- Significant rust staining at the socket termination, indicating internal corrosion and possible wire breaks.
- Significant reduction in diameter at the socket, indicating internal core breakage.
- Excess catenary, indicating internal wire breaks and loss of load carrying ability.

Inspecting Sheaves and Drums

Use the appropriately sized groove gauges to check sheaves for wear, keeping in mind that gauges designed for field use are based on differ-

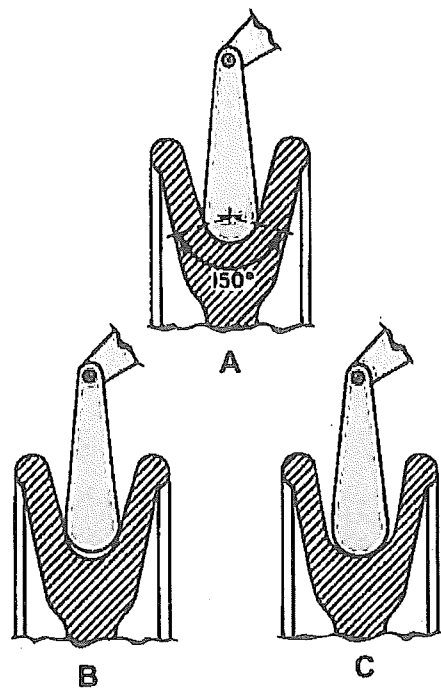


Figure 16 A sheave groove gauge should make 150° contact with the groove, as in Example A. Example B is too tight, and example C is too loose.

ent groove dimensions than those used by manufacturers for new components.

Field gauges are made to the rope's nominal or catalog diameter plus a minimum acceptable fractional oversize value based on the rope's diameter and construction.

This allows the gauges to be used to establish the minimum condition for worn grooves (Figure 16). When the gauge perfectly fits the groove, the groove is at the minimum allowable contour. Any narrower fit means the groove is not recommended for further use.

In addition to the groove contour, a full inspection includes the groove's depth, width and smoothness. Corrugations or "imprinting" caused by the rope's texture (Figure 17) can seriously damage the rope and is cause for replacing the sheave. Corrugation is more likely with bright rope than with plastic coated rope; plastic-coated rope may even help smooth the groove.

Also examine sheaves for damaged or chipped flanges, cracks in the hubs or spokes, out-of-roundness, waviness, alignment with other sheaves, and for wear or damage to bearings and shafts.

The main functional drums on shovels and draglines use grooved barrels with a single layer of rope. For drum inspections, check the drum's general operating characteristics. Adequate tension must be maintained on the rope so that it winds properly. Be sure the rope follows the groove and that the wraps are tight and consistent. If any looseness or irregular winding is observed, check the rope for kinks. Pay particular attention for any scuffing as it leaves the drum groove.

Measure the grooves for proper contour, as in the sheave inspection procedure above. Also check that adjacent grooves have enough clearance between them that one wrap of rope does not scrub the next wrap. Drums that become corrugated need to be corrected or replaced.

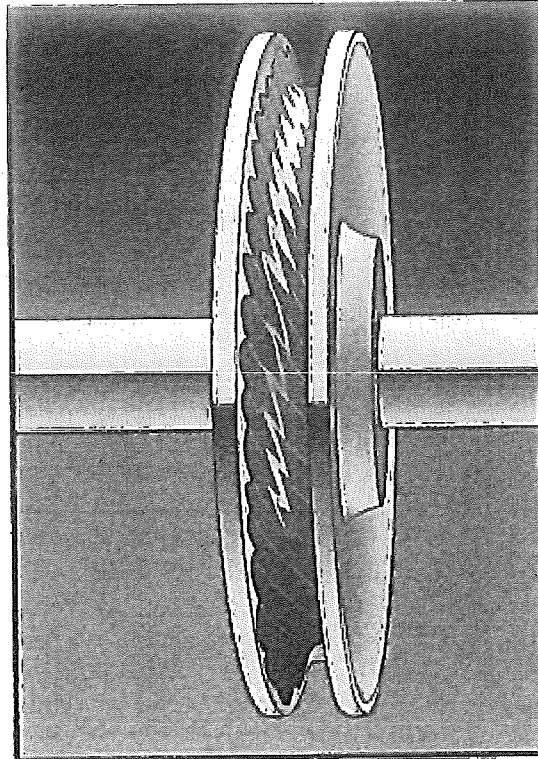


Figure 17 A corrugated sheave can cause serious damage to a wire rope.