



STEEL WIRE ROPE: INSPECTION & DISCARD STANDARDS

This e-book covers:

- wire rope wear and defects
- wire rope discard standards
- wire rope inspection

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The content of this e-book is written by Colin Rice on behalf of DrillSafe Southern Africa. DrillSafe Southern Africa is a safety initiative developed and run by Colin Rice Exploration Drilling Advisory, in an effort to improve safety performance in the exploration drilling industry.



In the course of doing safety audits on operational drill rigs over a number of years, I have come across some terrifying examples of badly worn or damaged hoist ropes that were clearly way beyond their safe working life, yet they were still in service. The danger posed by these ropes was significant but in all cases the contractor was oblivious to the risk. I then started asking contractors a simple question; “when do you change a hoist rope?” The responses I received were varied, some said “when one wire is broken”, others said “when 3 wires are broken”, there was no consistency in the responses and in many cases the contractor had not given the question much thought. The best response I got was, “I change the hoist rope before it breaks”!

Unfortunately, drill rig manufacturers give no guidance whatsoever on wire rope wear, inspection procedures or discard criteria and so many contractors operate at significant risk..

As wire ropes are used they will wear and develop one or more defects and so essentially, the contractor has to decide what wear and defects are acceptable and what wear and defects warrant the rope being discarded.

This is not a simple exercise and in trying to establish a standard, I researched many different industries that used steel wire ropes to see what we could apply to the drilling industry but none were of direct application. I have therefore borrowed elements of a number of different discard standards to create a very simple set of criteria that can easily be applied to the hoist ropes used in drilling applications. I hope that the criteria as well as the information on wire rope defects, wear and inspection are helpful to you.



STEEL WIRE ROPE

Wire ropes are used in exploration drilling as hoist ropes, wireline retrieval ropes and as pull-down and pull-back ropes and in all applications, the ropes work extremely hard. As the rope is used, abrasive wear of the outer wires will occur thereby reducing the metallic cross-section of the rope and hence the strength of the rope.

The rope will also be subject to cyclic stress reversals as it travels through the sheaves and spools off and onto the hoist drum, leading to fatigue breaks in individual wires.

Abrasive wear and wire breaks result in the rapid decrease of the breaking strength of the rope and as the strength of the rope decreases, the rope gradually approaches the end of its service life. The challenge is to determine how much abrasive wear and how many broken wires will indicate that the rope has reached the end of its service life and should be discarded. This is not a simple exercise but it is a critically important one and so it is important that a consistent inspection and discard standard is applied to all drilling operations to ensure that ropes are not used beyond their service life. Inspection of a steel wire rope requires that the person doing the inspection can detect some common indications of wear and other defects in the rope.

WIRE ROPE WEAR AND DEFECTS

Some of the most common defects found in steel wire ropes are shown below.



Broken wires

A broken wire cannot carry any load and so identification of this condition is an essential element of hoist rope inspection. The number of wire breaks will increase steadily during the life of the rope primarily due to abrasive wear on outer wires and fatigue caused by the rope travelling through sheave wheels.



Corrosion

Steel wire ropes used in the exploration industry generally have a galvanised finish and so corrosion is not a significant problem. If however a drill rig has been standing for a long period of time in hostile conditions, the hoist rope may have become corroded. Corrosion effectively reduces the metallic cross-section of the rope and so reduces the strength of the rope.



Reduction in diameter

The diameter of a wire rope can be reduced by failure of the rope core or by the rope being loaded beyond its' yield point. In both cases, the strength of the rope will be significantly reduced and so detection of this condition through regular inspection is essential. Any visible reduction in diameter of a rope will be a reason to discard the rope.

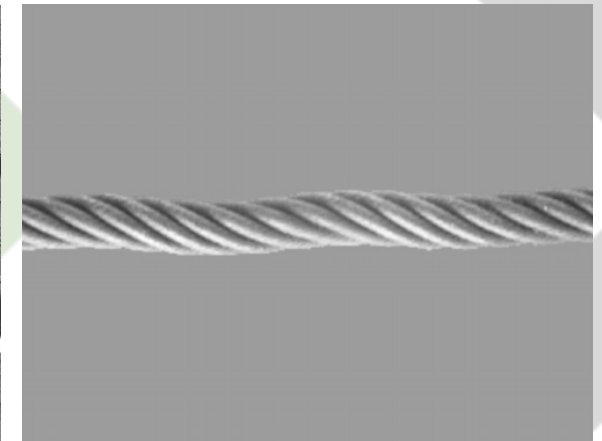
Kinks and waves

A number of defects can be induced in a steel rope through incorrect use or application.

The most common defects are kinks and waves that develop in ropes that are incorrectly spooled onto the hoist drum.

Frequently, contractors procure ropes in a roll (as shown below) and if the rope is spooled onto the hoist drum with the roll laying horizontally, a twist is induced in the rope and if the rope is then loaded, the twists become permanent kinks or waves in the rope. The photograph to the left shows a badly kinked hoist rope and the lower right photo show a rope with waves formed into it. A kink or wave can significantly reduce the strength of the rope as well as cause uneven spooling and uneven rope wear.

Wire ropes should never be ordered in a roll, as shown below, ropes must always be ordered on a drum so that it can be spooled onto the hoist or winch drum without inducing a twist in the rope. This will prevent kinks and waves being induced into the rope.



WIRE ROPE DISCARD STANDARDS

The consequences of a hoist rope failure can be catastrophic therefore it is essential that well-defined discard standards are developed and applied to steel wire ropes used in the drilling industry. Regular inspection of ropes must then be carried out to identify any discard criteria.

It is important to clearly distinguish between hoist rope and wireline ropes, the discard standards and inspection procedure suggested below are applicable to hoist ropes; wireline ropes will be discussed in a later publication.

The following criteria are suggested discard criteria for steel wire hoist ropes. Hoist ropes must be discarded if one or more of the following conditions are detected:

1. Three or more broken wires are found in close proximity to a rope termination.
2. Three or more broken wires are found in one strand.
3. Rope diameter anywhere along the rope is reduced to 90% of the nominal diameter.
4. A kink, wave, knot, loop, birdcage, localised flattening or any other defect is detected.

WIRE ROPE INSPECTION AND EXAMINATION

The frequency of inspection of hoist ropes should be clearly defined in the contractor's lifting equipment inspection policy but very few contractors address this critical issue. It is recommended therefore that all hoist ropes (and all other elements of lifting equipment and lifting tackle) are inspected by the Driller on a daily basis as a part of the pre-start inspection and then examined by a supervisor on a monthly basis.

It is important that the person/s entrusted with conducting inspections and examinations of wire rope are able to identify indications of wear and common defects and so make informed and objective decisions on when to discard a rope. This means that all persons who will be entrusted to inspect or examine wire ropes are trained in what to look for and how to look for defects when doing the inspection.

Pre-start inspection involves visually inspecting the rope, examination however is a little more complicated. Hoist rope reeving systems vary depending upon the location of the hoist, in some drills the hoist is mounted on the drill deck and in other it is mounted on the top of the mast.

In a typical 6-metre pull mast with the hoist mounted on the deck, we can think of the hoist rope being in 3 sections; the section in the front of the mast, the section behind the mast and the section on the hoist drum. The total length of the hoist rope will be 33 - 36 metres and so each of these sections of rope will be approximately 11 to 12 metres long. It is relatively simple therefore to visually inspect the entire length of rope by slowly spooling the rope off of the hoist drum and then back onto the hoist drum. The total length of the rope can then be examined as it spool off and then back onto the hoist drum. This also allows the hoist rope anchor on the drum to be inspected.



During the inspection, special attention must be placed on the following:

- areas with the highest number of stress reversal cycles caused by the rope moving through sheaves and onto and off of hoist drums. It is in these areas where the greatest number of fatigue wire breaks can be expected,
- areas at or closely adjacent to terminal fittings,
- areas of maximum wear on the hoist drum, the anchor point of the hoist rope onto the drum and the cross-over points on the drum (the places where a new layer of rope forms). These are places where increased abrasive wear can occur.

When re-spooling, ensure that the first layer of rope on the hoist drum is wound as tightly as possible to provide a firm base for following layers to spool onto.

If the hoist is mounted on the top of the mast or at an elevated position on the back of the mast, inspection is a little more difficult – the rope can be thought of as being in two sections, the working section and the section that remains on the hoist drum. Spooling the rope off the hoist will leave a section of the rope in the front of the mast that is not visually accessible if the mast is raised. This section will have to be examined from the back of the mast.

The consequences of a hoist rope failure can be catastrophic and so proper, regular inspection of hoist ropes is an essential part of a drill site safety management system. Equally as important is the application of discard standards to the inspection. Visual inspection can only identify external issues but severe internal damage may also accompany the external wear or defects. When deciding on whether to keep a rope in service or to discard it, it is always better to err on the side of caution.

Look out for related e-books covering other important aspects of wire ropes and;

- **Steel wire ropes: Construction & selection**
- **Synthetic ropes**
- **Ultra-high strength ropes**
- **Swaged ropes**

 www.drillsafe.co.za

 [@DrillSafe-Southern-Africa](https://www.linkedin.com/company/DrillSafe-Southern-Africa)

 team@drillsafe.co.za

