Wire Rope Inspection

The most widely used wire rope replacement, inspection and maintenance standard for mobile-type cranes is ASME B30.5, section 5-2.4. The following is an excerpt from that standard.

All running ropes in service should be visually inspected once each working day. A visual inspection shall consist of observation of all rope which can reasonably be expected to be in use during the day's operations. These visual observations should be concerned with discovering gross damage, such as listed below which may be an immediate hazard:

[A] Distortion of the rope such as kinking, crushing, unstranding, birdcaging, main strand displacement, or core protrusion. Loss of rope diameter in a short rope length or unevenness of outer strands should provide evidence that the rope must be replaced.
[B] General Corrosion
[C] Broken or Cut strands
[D] Number, distribution, and type of visible broken wires
[E] Core failure in rotation resistant ropes: when such damage is discovered, the rope shall be either removed from service or given an inspection (further detail per S-2.4.2).

The frequency of detailed and thorough inspections should be determined by a qualified person, who takes into account the following factors:

- Expected rope life as determined by [a] maintenance records, and [b] experience on the particular installation or similar installations
- Severity of environment
- Percentage of capacity lifts
- Frequency rates of operation, and exposure to shock loads

Inspect the entire length of the rope. Some areas of the wire rope such as around the core are more difficult to inspect. To inspect the core, examine the rope as it passes over the sheaves. The strands have a tendency to open up slightly which will afford the inspector a better view of the core. Also regularly inspect for any reduction in diameter and lengthening of rope lay as both conditions indicate core damage.

Basic Guidelines

Abrasion Abrasion damage may occur when the rope contacts an abrasive medium or simply when it passes over the drum and sheaves. Therefore it is vital that all components be in proper working order and of the appropriate diameter of the rope. A badly corrugated or worn sheave or drum will seriously damage a new rope, resulting in premature rope replacement.

Corrosion Corrosion is very difficult to evaluate but is a more serious cause of degradation than abrasion. Usually signifying a lack of lubrication, corrosion will often occur internally before there is any visible external evidence on the rope's surface. A slight discoloration caused by rusting usually indicates a need for lubrication which should be tended to immediately. If this condition persists, it will lead to severe corrosion which promotes premature fatigue failures in the wires and strands, necessitating the rope's immediate removal from service.

Wire Breaks The table below shows the number of allowable wire breaks per crane type. The inspector must know the ASME standard for the equipment being inspected. The number of broken wires on the outside of the wire rope is an indication of its general condition and whether or not it must be considered for replacement. The inspector may use a type of spike to gently probe the strands for any wire breaks that do not protrude. Check as the rope runs at a slow speed over the sheaves, where crown (surface) wire breaks may be easier to see. Also examine the rope near the end connections. Keeping a detailed inspection record of the wire breaks and other types of damage will help the inspector determine the elapsed time between breaks. Note the area of the breaks and carefully inspect these areas in the future. Replace the rope when the wire breaks reach the total number allowable by ASME or other applicable specifications.

ASME No.	Equipment	No. Broken Wries in Running Ropes in		No. Broken Wries in Standing Ropes in	
		One Rope Lay	One Strand	One Rope Lay	One Strand
B30.2	Overhead and Gantry Cranes	12*	4	N/A	N/A
B30.4	Portal, Tower and Pillar Cranes	6*	3	3*	2
B30.5	Crawler, Locomotive & Truck Cranes	6*	3	3*	2
B30.6	Derricks	6*	3	3*	2
B30.7	Base-Mounted drum Hoists	6*	3	3*	2
B30.8	Floating Cranes & Derricks	6*	3	3*	2
A10.4	Personnel Hoists	6*	3	2*	2
A10.5	Material Hoists	6*	N/A	N/A	N/A

* Also remove for **ONE** valley break. OSHA require monthly record keeping of wire rope conditions. NOTE: current industry recommendations and OSHA standards are based upon steel sheaves. The manufacturer of plastic and synthetic sheaves or liners should be consulted for its recommendation on the safe application of the product and inspection criteria.

Valley breaks, or breaks in between strands, must be taken very seriously at all times! **When two or more valley breaks are found in one lay-length, immediately replace the rope.** Valley breaks are difficult to see; however, if you see one you can be assured that there are a few more hidden in the same area. Crown breaks are signs of normal deterioration, but valley breaks indicate an abnormal condition such as fatigue or breakage of other wires such as those in the core.

Once crown and valley breaks appear, their number will steadily and quickly increase as time goes on. The broken wires should be removed as soon as possible by bending the broken wire back and forth with a pair of pliers. In this way the wire is more likely to break inside the rope where the ends will be tucked away. If the broken wires are not removed they may cause further damage.

The inspector must obey the broken wire standard; pushing the rope for more life will create a dangerous situation.

Diameter Reduction. Diameter reduction is critical deterioration factor and can be caused by:

- Excessive abrasion of the outside wires
- Loss of core diameter/support
- Internal or external corrosion damage
- Inner wire failure
- A lengthening of rope lay

It is important to check and record a new rope's actual diameter when under normal load conditions. During the life of the rope the inspector should periodically measure the actual diameter of the rope at the same location under equivalent loading conditions. This procedure if followed carefully reveals a common rope characteristic--after an initial reduction, the overall diameter will stabilize and slowly decrease in diameter during the course of the rope's life. This condition is normal. However, if diameter reduction is isolated to one area or happens quickly, the inspector must immediately determine (and correct, if necessary) the cause of the diameter loss, and schedule the rope for replacement.

Crushing. Crushing or flattening of the strands can be caused by a number of different factors. These problems usually occur on multilayer spooling conditions but can occur by simply using the wrong wire rope construction. Most premature crushing and/or flattening conditions occur because of improper installation of the wire rope. In many cases failure to obtain a very tight first layer (the foundation) will cause loose or "gappy" conditions in the wire rope which will cause rapid deterioration. Failure to properly break- in the new rope, or worse, to have no break-in procedure at all, will cause similar poor spooling conditions. Therefore, it is imperative that the inspector knows how to inspect the wire rope as well as how that rope was installed.

Shock loading. Shock loading (birdcaging) of the rope is another reason for replacement of the rope. Shock loading is caused by the sudden release of tension on the wire rope and its resultant rebound from being overloaded. The damage that occurs can never be corrected and the rope must be replaced.

High Stranding. High stranding may occur for a number of reasons such as failure to properly seize the rope prior to installation or maintain seizing during wedge socket installation. Sometimes wavy rope occurs due to kinks or a very tight grooving problem. Another possibility is simply introducing torque or twist into a new rope during poor installation procedures. This condition requires the inspector to evaluate the continued use of the rope or increase the frequency of inspection.

Inspection Guidelines - Specialty Ropes

Plastic-Infused Rope. Plastic-infused rope was developed to provide better fatigue, abrasion and crushing resistance derived from the cushioning and dampening effect of the plastic. However great the benefits, the plastic becomes at the very least an inconvenience when trying to inspect the wire rope. Because of the plastic coating, some operators choose to forego inspection and run the ropes to failure. Other operators may just visually inspect the plastic coating. Both practices are wrong and carry equally the potential for disaster.

Abrasion and Crushing. In inspecting plastic-infused ropes, the basic inspection guidelines still apply and should be followed. Abrasion and crushing damage may still occur, so it is imperative to inspect flanges, sheaves, bearings, rollers and fairleads. Look for unusual wear patterns in the plastic-- a key indicator that damage to the wire rope is occurring.

Wire Breaks. Wire breaks will still occur in a plastic-infused rope, but are sometimes extremely difficult to detect, though occasionally a broken wire will protrude through the plastic. Every effort must be made to determine the overall condition of the rope. The plastic covering the crown (surface) wires is generally applied in a thin coat and tends to wear quickly in areas which pass over sheaves and drums. As the rope runs at a slow speed, inspect the rope in these areas. As the rope and plastic open up the inspector will be afforded a look at not only the surface area but also the inter-strand contact points. If a valley break is detected, immediately pull the ropes from service. Also inspect areas where plastic has peeled, regardless of the location of the "window." Remove as much plastic from these areas as possible to allow for efficient and effective inspection techniques. Remember, due to the nature of plastic-infused ropes, there is no way to clearly determine the number of valley breaks.

Corrosion. Plastic-infused ropes provide only improved corrosion resistance. Regardless of manufacturers' claims, a plastic-infused rope can corrode, and rope failure due to corrosion is still possible. Moisture is sometimes trapped in the rope and as with all machines, the lubricant may become ineffective over time. The inspector must visually check for any signs of corrosion damage as evidenced by rope bleeding or rouging. In addition, the diameter must be frequently measured. If there is any damage to the core, it will be detected by a reduction in diameter. Also inspect the lay of the rope. As the plastic is thinner over the crown wires, a thorough inspection may be able to determine a lengthening of lay, also a sign of rope deterioration. Especially when trying to determine lengthening of lay, watch for and inspect areas where the plastic pulls away from the rope. While peeling in and of itself is not an indication of rope deterioration and is a factor of normal wear, peeling in areas where no abrasion exists may signify a problem.

Maintenance Records. Equally important in inspecting plastic-infused ropes is maintaining accurate service records. The service records of previous ropes will provide a guideline as to the expected life of the rope. However, they should not be used alone or only in conjunction with visual inspections due to the number of variables which exist, including installation, spooling and manufacturinng practices. Maintenance records must be used in combination with both visual and physical inspection techniques to be truly of value in determining the remaining life of the rope.

Compacted Rope. Die drawn and swaged ropes fall into the compacted category. Compacting serves several purposes. By flattening the outer wires, metallic area increases allowing for a higher breaking strength as well as improved crushing and abrasion resistance. In addition, the compaction minimizes interstrand nicking and thereby improves fatigue resistance.

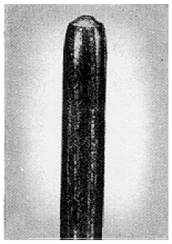
In the inspection of compacted rope designs, again it is imperative to follow the basic inspection guidelines and use both visual and actual measuring techniques to determine the remaining life of the rope. In fact, actual measuring techniques are very important when inspecting these ropes. While corrosion is relatively easy to visually determine, diameter reduction may not be due to the compacted rope's appearance. Therefore the inspector must regularly measure for diameter reduction and closely examine the rope for lay lengthening. Measurements must be recorded and the rope monitored for sudden variations.

By and large the most difficult retirement criteria to determine in compacted ropes is wire breaks. These breaks may not protrude from the rope due to the compaction and can be easily overlooked. Because of this, the inspector must slowly and carefully examine the rope, especially in those areas passing over drums and sheaves or in areas where problems existed in previous ropes.

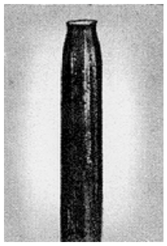
A wire break may appear as nothing more than a crack in the wire, and again can be easily overlooked. If the inspector notes a "flaw" in a wire, it should be carefully checked. The inspector should carry some type of magnifying device to determine if a flaw is actually a break. If a break has occurred, thoroughly check the area for additional breaks, both on the crown and in the valleys. Remember, valley breaks in round strand ropes are difficult to determine; compaction only increases the difficulty. The inspector must be slow and methodical in inspecting compacted ropes; a quick check will reveal nothing.

Overall, perhaps the most important inspection technique is recognizing the limits of wire rope. While it's true that compacted and plastic infused ropes are more durable, neglect and abuse will still quickly end the rope's life. There is no substitute for proper installation, handling and inspection techniques in combination with a preventative maintenance program.

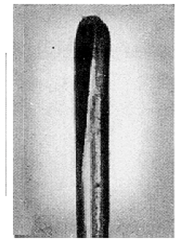
Troubleshooting Checklist



Tension (Cone)



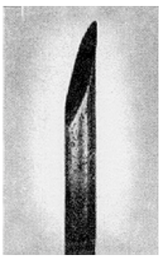
Tension (Cup)



Tension & Wear

Tension Break

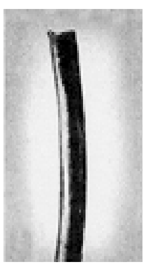
Wire break shows one end of broken wire coned, the other cupped. Necking down of the broken ends is typical of this type break. Where tension breaks are found, the rope has been subjected to overloading, either for its original strength (new rope) or for its remaining strength in the case of a used rope. Tension breaks frequently are caused by the sudden application of a load to a slack rope, thereby setting up incalcuable impact stress.



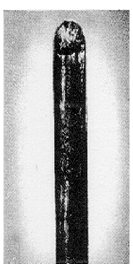
Abrasion

Abrasion Break

Wire break shows broken ends worn to a knife-edge thinness. Abrasive wear obviously is concentrated at points, where the rope contacts an abrasive medium, such as the grooves of sheaves and drums, or other objects with which the rope comes into contact. Unwarranted abrasive wear indicates improperly grooved sheaves and drums, incorrect fleet angle, or other localized abrasive conditions.

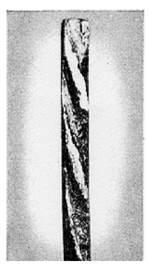


Fatigue
(Square type)



Fatigue
(Jagged type)

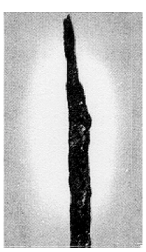
Fatigue & Wear



Fatigue & Nicking

Fatigue Break

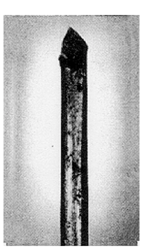
Wire breaks are usually transverse or square showing granular structure. Often these breaks will develop a shattered or jagged fracture, depending on the type of operation. Where fatigue breaks occur, the rope has repeatedly been bent around too small a radius. Whipping, vibration, slapping and torsional stresses will also cause fatique. Fatigue breaks are accelerated by abrasion and nicking.



Corrosion

Corrosion Break

Easily noted by the wire's pitted surface, wire breaks usually show evidence of tension, abrasion and/or fatigue. Corrosion usually indicates improper lubrication. The extent of the damage to the interior of the rope is extremely difficult to determine; consequently corrosion is one of the most dangerous causes of rope deterioration.



Cut or Shear

Cut or Shear

Wire will be pinched down and cut at broken ends, or will show evidence of shear-like cut.
This condition is evidence of mechanical abuse caused by agents outside the installation, or by something abnormal on the installation itself, such as a broken flange.

ABRASION

Frozen sheaves or rollers
Tight grooves
Excessive fleet angle
Oversized or undersized rope
Corrugated sheave or drum
Sheave overspin
Rope jumping the sheave
Poor spooling
Misaligned sheaves
Site contaminants

CORE PROTRUSION AND SLIPPAGE

Shockloading
Poor seizing techniques
Poor installation techniques

CORROSION

Lack of lubrication
Environmental damage, e.g. acidic
Fume exposure
Improper storage

CRUSHING

Poor installation techniques
Crosswinding
Poor Spooling
Incorrect wire rope construction
Poor break-in procedure
Excessive fleet angle
Excessive rope length

DIAMETER REDUCTION

Lack of lubrication (fiber core)
Excessive abrasion
Corrosion, internal and/or external
Inner wire or core failure

FATIGUE

Out of round sheaves
Tight grooves
Misaligned sheaves
Undersized sheaves
Worn bearings
Vibration
Slapping
Whipping
Reverse bends

HIGH STRANDING

Poor seizing techniques
Tight grooves
Undersized sheaves
Poor installation techniques

JUMPING THE SHEAVE

Poor spooling
Excessive rope length
Broken flange

KINKING

Poor unreeling procedures
Poor installation techniques
Undersized sheaves

LAY LENGTHENING & TIGHTENING

Poor installation techniques
Poor unreeling procedures
Corrosion
Core Failure

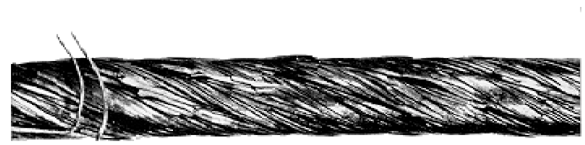
LOOPED WIRES

Poor installation techniques
Undersized sheaves

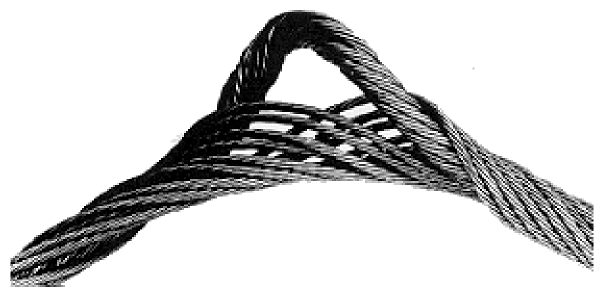
UNBALANCED ROPE

Oversized sheaves

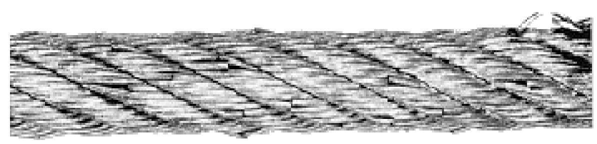
Abrasion



Core Protrusion (Shockloading)

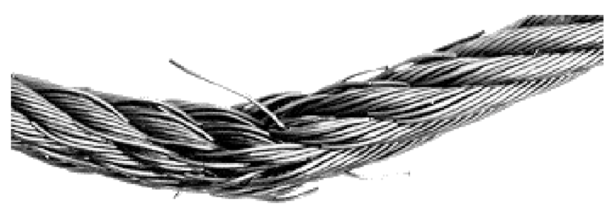


Corrosion



Crushing

Fatigue (Reverse Bend)



Fatigue (Undersized Sheave)