06/2014

WIRE ROPE INSPECTION

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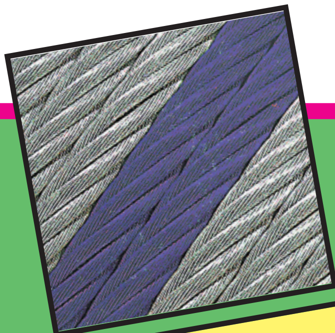
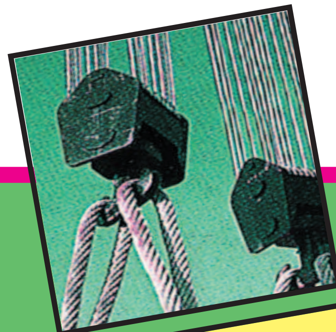
Inspection | Handling | Installation | Maintenance | Engineering

UNIROPE SLINGMAX WIRE ROPE & RIGGING PRODUCTS

1956 63 2019

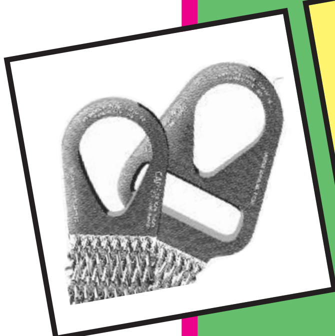
Serving Canadian Industry
for over 63 years

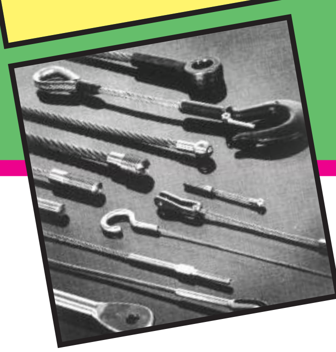




Products & Services

Wire Rope Inch, Metric, Overhead
Python® High Performance Ropes
Python Compac® Non-Rotating Wire Rope
Uni-Loc® Assemblies
Gator-Flex® 9-part Wire Rope Slings
Tri-Flex® 3-part Wire Rope Slings
Rigger's Choice® Grade 80/100 Chain Slings
Gripper® Wire Mesh Slings
Uni-Web® Synthetic Web Slings
Uni-Path® Polyester Round Slings
Twin-Path® High Performance Slings
Attachments Clamps, Beams, Scales
Fittings Crosby, RUD, Green Pin
Inspection Chain, Wire Rope, Slings ....
Proof Testing ASTM E4, Lloyd's Register





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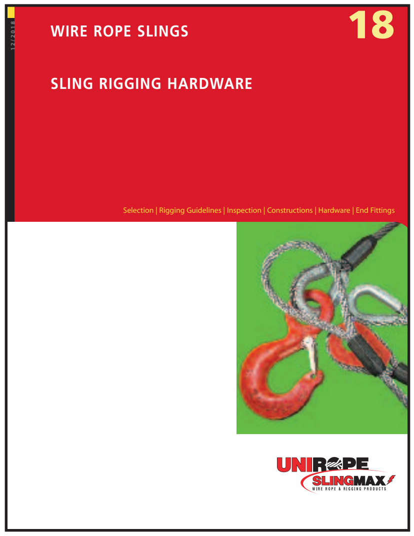
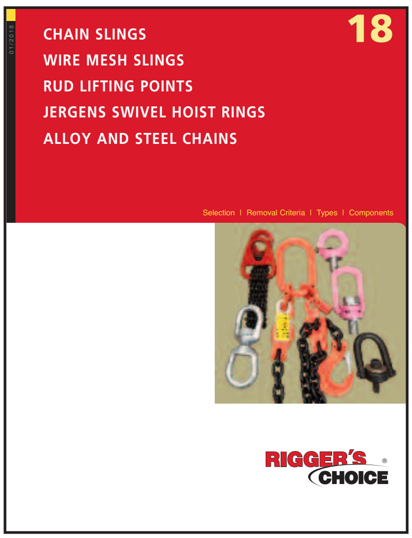
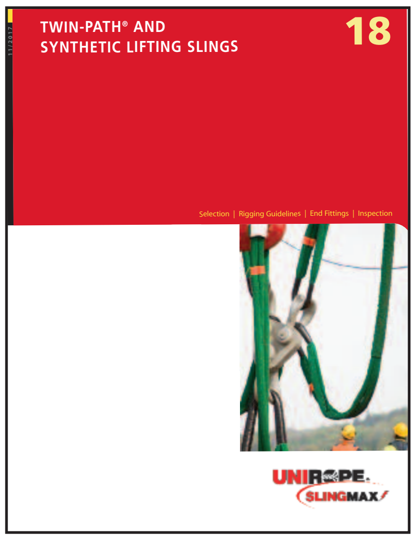
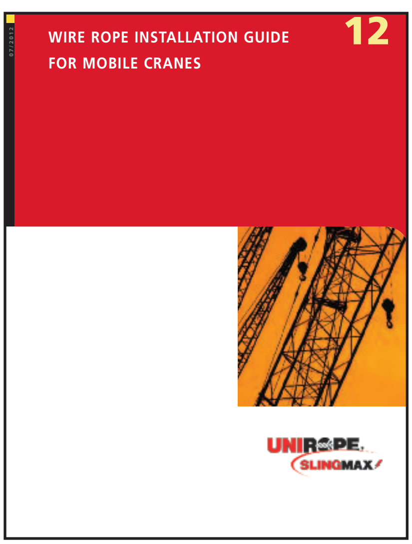
Parts of this Inspection manual are based on:
“RIGGING MANUAL” published by the Construction safety Association of Ontario, 21 Voyager Court South, Etobicoke, ON. M9W 5M7, Canada
“WIRE ROPE USERS MANUAL” published by the ‘Wire Rope Technical Board’, PO Box 266, Woodstock, Maryland, 21163-0286, USA
Some of the content of both publications was adopted to incorporate Python® wire rope, Unirope® and VDW specifications. For a complete discussion on the subject on wire rope we highly recommend both publications. In addition, the ‘Construction Safety Association of Ontario’ has published a ‘Construction Health & Safety Manual’, a ‘Crane Handbook’ and a ‘Mobile Crane Manual’. To order these publications please write to the above mentioned organizations, or call Unirope Limited.

UNIROPE® SLINGMAX









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WARNING

Any warranties, expressed or implied, concerning the use of Wire Rope Products apply to the minimum breaking strength of new, unused Wire Rope when tested in a standard testing machine, under controlled conditions, in direct tension, with both ends fixed to prevent rotation under load, and at a uniform rate of speed. The Terms 'Working Load Limit (WLL)', 'Capacity', 'Minimum Breaking Strength', 'Nominal Breaking Strength', or 'Acceptance Strength' contains no implication of what load a Wire Rope will withstand if not properly used, or if it suffers abuse. All equipment using Wire Rope must be properly maintained. Wire Rope and their attached hardware must be properly stored, handled, used and maintained. Most importantly, Wire Rope and their attached hardware must be regularly inspected before and during each use. Inspections must meet local, or applicable national safety regulations. Damage, abuse, overloading, or improper maintenance can cause failure and accidents. Wire Rope removal criteria are based on steel sheaves. If synthetic sheaves are used, consult the sheave manufacturer. If in doubt about the safe and proper use of these products consult Unirope Limited 1.800.457.9997

Use and Care of Wire Rope

Some Things Every User Should Know About Use and Care of Wire Rope

What follows is a brief outline of the basic information required to safely use wire rope

1. Wire rope WILL FAIL IF WORN OUT, OVERLOADED, MISUSED, DAMAGED, or IMPROPERLY MAINTAINED.

2. In service, wire rope loses strength and work capability. Abuse and misuse increase the rate of loss.

3. The MINIMUM BREAKING STRENGTH of wire rope applies ONLY to a NEW, UNUSED rope.

4. The Minimum Breaking Strength should be considered the straight line pull with both rope ends fixed to prevent rotation, which will ACTUALLY BREAK a new, UNUSED, rope. The Minimum Breaking Strength of a rope should NEVER BE USED AS ITS WORKING LOAD.

5. To determine the working load of a wire rope, the MINIMUM or NOMINAL Breaking Strength MUST BE REDUCED by a DESIGN FACTOR (formerly called a Safety Factor). The Design Factor will vary depending upon the type of machine and installation, and the work performed. YOU must determine the applicable Design Factor for your use.

   For example, a Design Factor of "5" means that the Minimum- or Nominal Breaking Strength of the wire rope must be DIVIDED BY FIVE to determine the maximum load that can be applied to the rope system.

   Design Factors have been established by DIN, ISO, CEN, OSHA, ANSI, ASME and similar government and industrial organizations.

   No wire rope should ever be installed or used without full knowledge and consideration of the Design Factor for the application.

6. WIRE ROPE WEAR OUT. The strength of a wire rope slightly increases after the break in period, but will decrease over time. When approaching the finite fatigue life span the breaking strength will sharply decrease. Never evaluate the remaining fatigue life of a wire rope by testing a portion of a rope to destruction only. An indepth rope inspection must be part of such evaluations.

7. NEVER overload a wire rope. This means NEVER use the rope where the load applied is greater than the working load determined by dividing the Minimum Breaking Strength of the rope by the appropriate Design Factor.

8. NEVER 'SHOCK LOAD' a wire rope. A sudden application of force or load can cause both visible external damage (e.g. birdcaging) and internal damage. There is no practical way to estimate the force applied by shock loading a rope. The sudden release of a load can also damage a wire rope.

9. Lubricant is applied to the wires and strands of a wire rope when manufactured. This lubricant is depleted when the rope is in service and should be replaced periodically.

10. Regular, periodic INSPECTIONS of the wire rope, and keeping of PERMANENT RECORDS SIGNED BY A QUALIFIED PERSON, are required by OSHA and other regulatory bodies for almost every rope installation. The purpose of inspection is to determine whether or not a wire rope may continue to be safely used on that application. Inspection criteria, including number and location of broken wires, wear and elongation, have been established by DIN, ISO, CEN, OSHA, ANSI, ASME and other organizations.

IF IN DOUBT, REPLACE THE ROPE.

Some inspection criteria on rope, sheaves and drums are outlined further in this brochure.

11. When a wire rope has been removed from service because it is no longer suitable, IT MUST NOT BE RE-USED ON ANOTHER APPLICATION.

12. Every wire rope user should be aware of the fact that each type of fitting attached to a wire rope has a specific efficiency rating which can reduce the working load of a rope assembly or rope system, and this must be given due consideration in determining the capacity of a wire rope system.

13. Some conditions that can lead to problems in a wire rope system include:

    ° Sheaves that are too small, worn or corrugated can cause damage to wire rope.
    ° Broken wires mean a loss of strength.
    ° Kinks permanently damage a wire rope.
    ° Environmental factors such as corrosive conditions and heat can damage a wire rope.
    ° Lack of lubrication can significantly shorten the useful service life of a wire rope
    ° Contact with electrical wire and the resulting arcing will damage a wire rope

The above is the partially rewritten publication 'WIRE ROPE AND SLING SAFETY BULLETIN' . Some of it's content was adapted to our specific requirement and does not truly reflect the original as published by the WIRE ROPE TECHNICAL BOARD.

Wire Rope is a Machine

A wire rope is a machine, by dictionary definition:"An assemblage of parts...that transmit forces, motion, and energy one to another in some predetermined manner and to some desired end."

A typical wire rope may contain hundreds of individual wires which are formed and fabricated to operate at close bearing tolerances one to another. When a wire rope bends, each of its many wires slides and adjusts in the bend to accommodate the difference in length between the inside and the outside bend. The sharper bend, the greater movement.

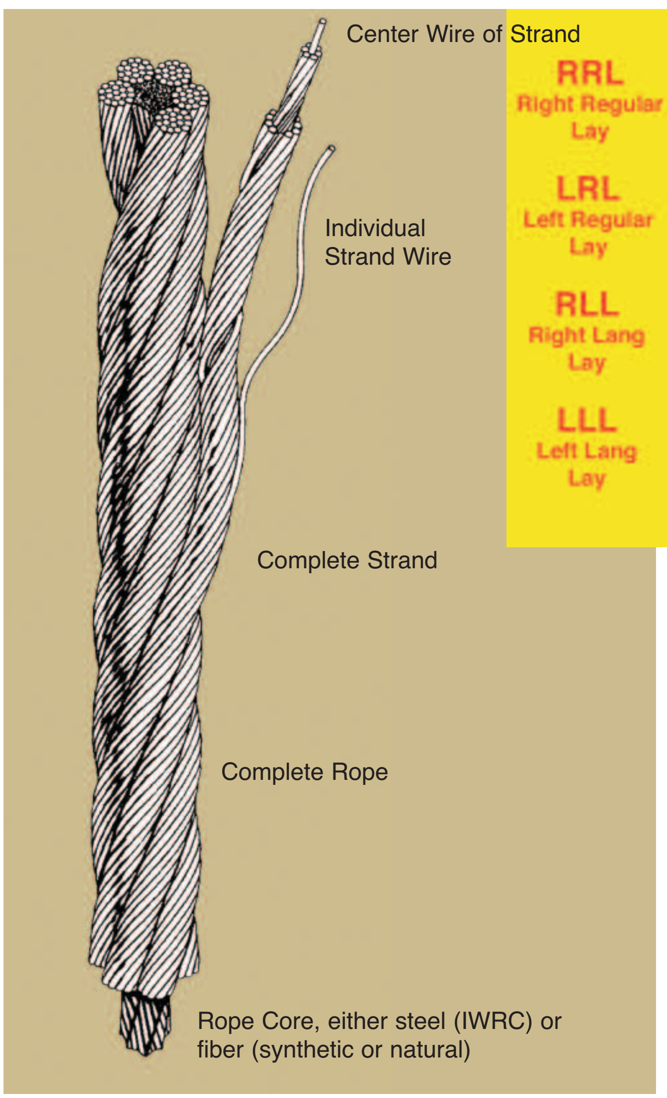
Every wire rope has three basic components:
(1) The wires which form the strands and collectively provide the rope strength;
(2) The strands, which are helically around the core; and,
(3) The core, which forms a foundation for the strands.

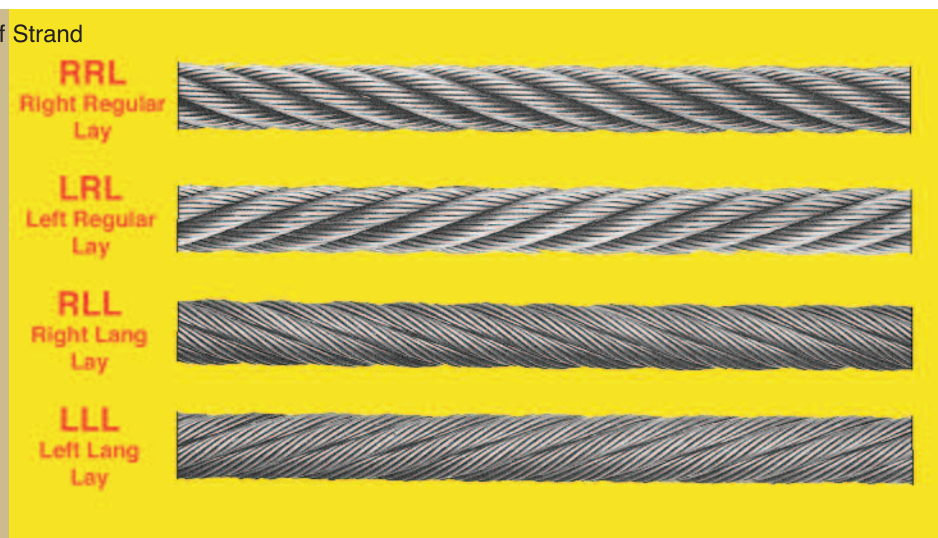
The core of wire rope may be an Independent Wire Rope Core (Steel Core, IWRC, SE, or CW) , which in many cases is actually a rope in itself. This core provides between 10% and 50% (in non-rotating constructions) of the wire rope's strength.

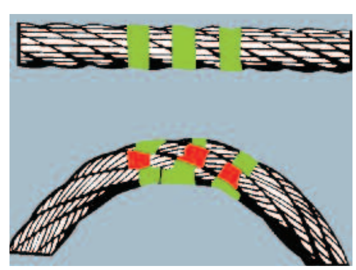
The greatest difference in wire ropes are found in the number of strands, the construction of strands, the size of the core, and the lay direction of the strand versus the core.

The wires of wire rope are made of high-carbon steel. These carbon steel wires come in various grades. The term "Grade" is used to designate the strength of the wire rope. Rope wires are usually made of 1770 N/mm2, 1960 N/mm2, or 2160 N/mm2 steel grades [Approximate equivalents are Improved Plow Steel (IPS), Extra Improved Plow Steel (EIPS) or Extra Extra Improved Plow Steel (EEIPS)]

One cannot determine the Tensile Grade of a wire rope by its feel or appearance. To properly evaluate a rope's tensile grade you must obtain the Grade from your employer or Unirope Limited @ 1.800.457.9997







Flexing the rope makes the strands slide against each other.

Installation of Wire Rope

Foreword

In order to fully achieve the service life potential of Python™ and standard wire rope for demanding crane jobs these step by step instructions should be followed. They are intended to prevent rope damage caused by kinks, untwisting, and loose strands, during handling and installation.

We realize that the 'real world' is not perfect. This applies also to wire rope installation. It is impossible to cover ALL imaginable installation situations, location difficulties, and crane set ups. You will also find that these instructions are not very different from the installation procedure of 6-strand or 19x7 ropes. Many experienced Riggers may find some of the following "old hat". If you notice any omissions or have ideas that we can incorporate into this brochure we will be most appreciative.

Measuring the rope diameter

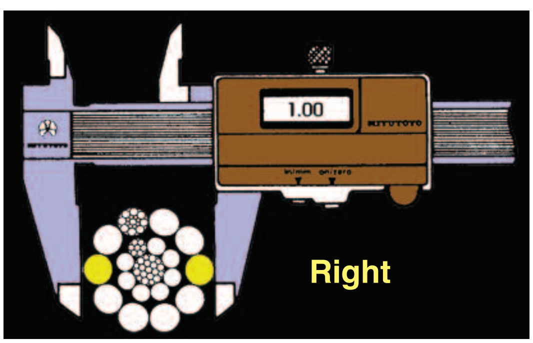
Before you start anything, make sure the diameter of the new rope you are about to install is the correct one for your crane.

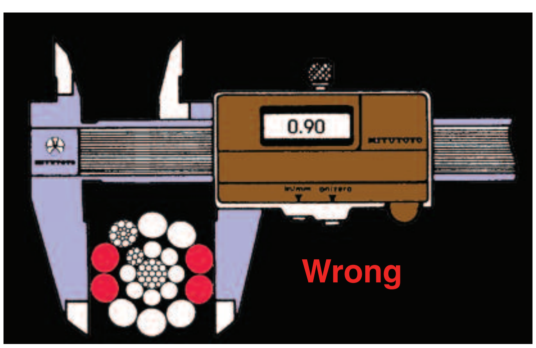
Remember that most wire ropes measure slightly over their nominal diameter. Standard rope is allowed to measure up to 5% over their nominal diameter. Some PYTHON® wire rope is made with a maximum 4% tolerance only.

The rope you are going to replace may be worn and may measure less than the rope you are about to install.

Keep a record of the new rope diameter for future references. You will be asked to determine how much the rope diameter has decreased in service and you MUST know the ACTUAL diameter of the wire rope after the break in period (see page 11).

When measuring the rope, don't measure the layer on the reel. Pull a couple of feet off the reel and measure the rope when straight. It is advisable to take 4 measurements of the rope round it's axis and average the results.





4% Diameter Tolerances

Nominal Diameter mm	Maximum Diameter mm	Nominal Diameter inch	Maximum Diameter inch
10	10.40	3/8	.39
11	11.45	7/16	.45
12	12.50	1/2	.52
14	14.55	9/16	.59
15	15.60	5/8	.65
16	16.65	3/4	.78
18	18.70	7/8	.91
20	20.80	1	1.04
22	22.90	1-1/8	1.17
24	25.00	1-1/4	1.30
26	27.05	1-3/8	1.43
28	29.10	1-1/2	1.56
30	31.20	1-5/8	1.69
32	33.30	1-3/4	1.82
34	35.35	1-7/8	1.95
36	37.45	2	2.08

5% Diameter Tolerances

Nominal Diameter mm	Maximum Diameter mm	Nominal Diameter inch	Maximum Diameter inch
10	10.50	3/8	.40
11	11.50	7/16	.46
12	12.60	1/2	.53
14	14.70	9/16	.59
15	15.70	5/8	.65
16	16.80	3/4	.79
18	18.90	7/8	.92
20	21.00	1	1.05
22	23.10	1-1/8	1.18
24	25.20	1-1/4	1.31
26	27.30	1-3/8	1.44
28	29.40	1-1/2	1.58
30	31.50	1-5/8	1.71
32	33.60	1-3/4	1.84
34	35.70	1-7/8	1.97
36	37.80	2	2.10

Installation of Wire Rope

If you have to cut a rope

Usually, you do not need to re-cut a wire rope. However, you may encounter situations where it becomes necessary to shorten the rope.

Be aware that the following constructions are just lightly preformed and are ALWAYS heat sealed (induction tapering) at the end:
Python® Multi
Python® Super 8, Type R, C, and V
Python® Power 9, Type R and V
Python® Ultra
Python® Lift
Python® Hoist
Python® Compac 35
Python® Compac 18
19 x 7/19x19 (depending on diameter)
34 x 7

The heat seal, which is sometimes coated with a red plastic material, prevents the rope ends from unraveling. Most Python® constructions are NOT preformed. Cutting without proper care WILL result in permanent damage of the rope.

In cutting any wire rope special care MUST be taken in seizing the rope end.
Two methods are suggested:
1) Seizing the rope end with soft iron wire.
2) Seizing the rope end with hose clamps.

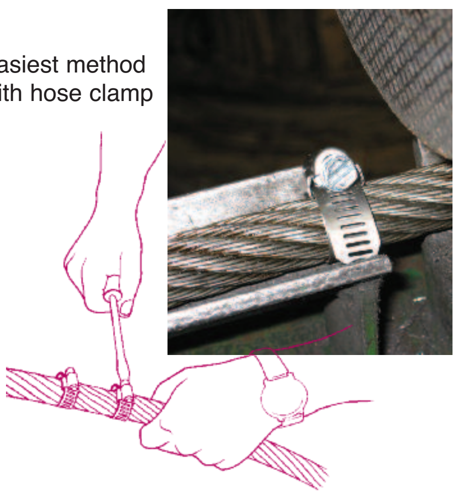
After cutting the rope (see below) it is good practice to braze PYTHON®, 19 x 7, and 34 x 7 rope ends to ensure that they don't unravel. Leave the seizing on the rope for added holding strength. Be careful not to damage the seizing while brazing.

We found that blade cutting a rope gives the best results. Be sure to use a cutting blade suitable for the job (We use cutting blades made by 'PFERD-HORSE' type ELASTIC # 80 EHT 230-2 A 24 SG INOX.) Follow the safety precautions for free hand cutting.

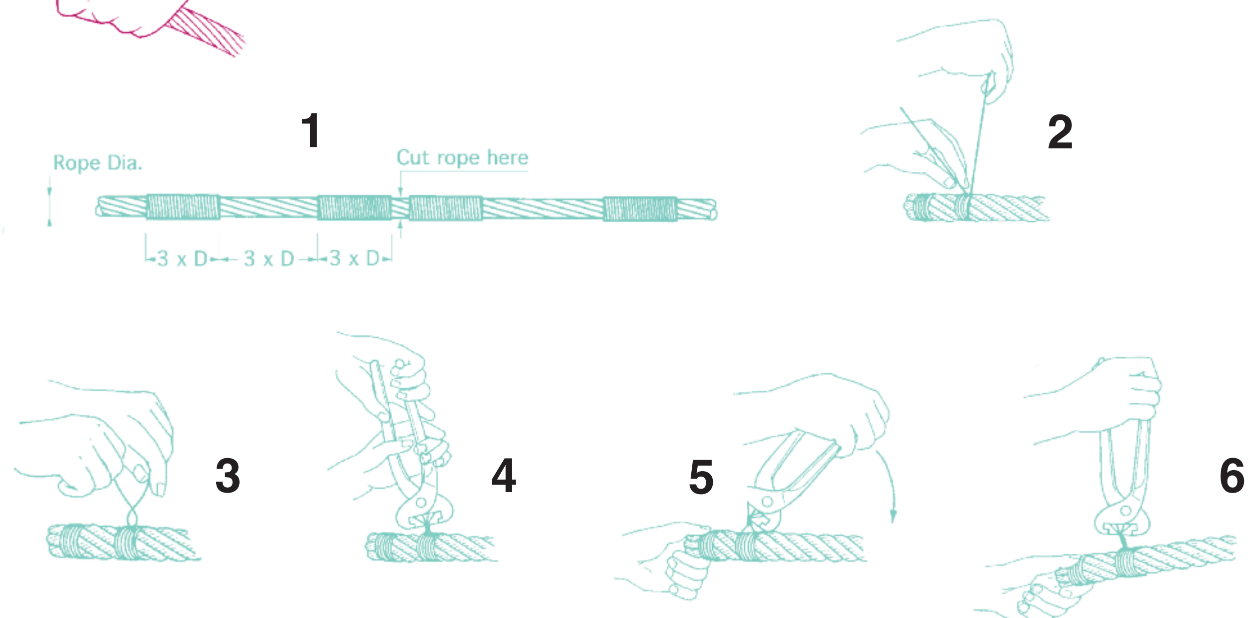
Cutting a rope with a torch may result in both uneven ends and damage to the seizing causing the strands to open up.

Rope diameter up to 14 mm (9/16") may be cut with a FELCO C16 hand cutter.

Easiest method with hose clamp



Traditional method with seizing wire



Installation of Wire Rope

Unreeling the rope

When removing the rope from the shipping reel or coil, the reel or coil MUST rotate as the rope unwinds. Any attempt to unwind a rope from stationary reel or coil WILL result in a kinked rope that is ruined beyond repair.

The following illustrations demonstrate the right and wrong way of unreeling a rope.

Special care must be taken **not** to drag the rope over obstacles, over a deflection shaft, or around corners.

Avoid large fleet angles between the shipping reel and the first sheave. The rope may roll in the sheave causing the rope to unlay. This is particularly important for all DoPar-, langs lay, and non-rotating rope constructions.

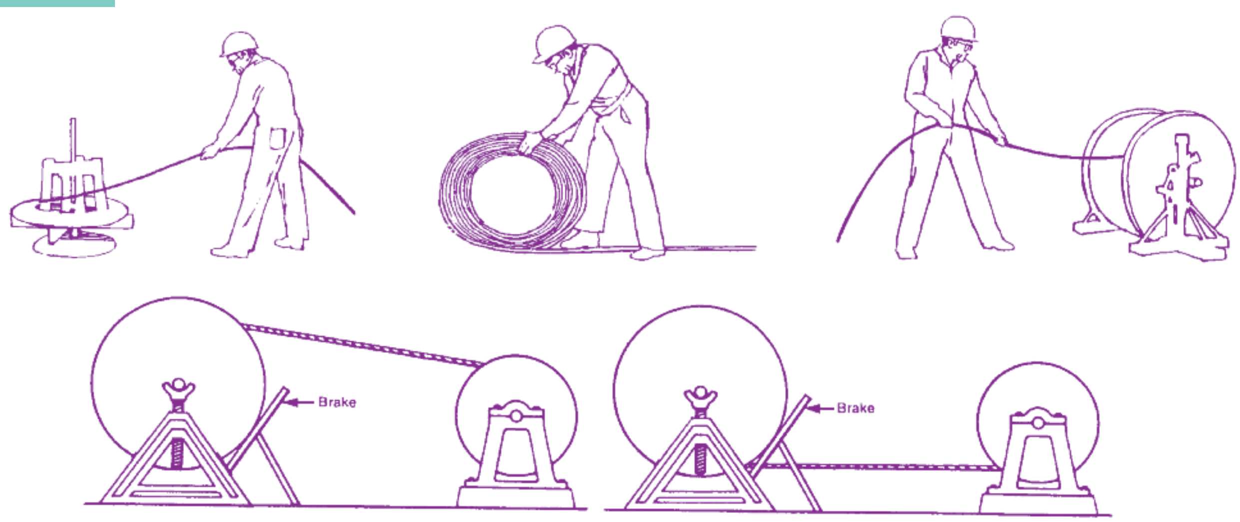
Avoid reeving the rope through small deflection sheaves and avoid changing the plane from vertical to horizontal direction.

If you have to unspool large and heavy wire rope, use a brake to keep a slight tension on the rope. NEVER let the rope go slack and form loops.

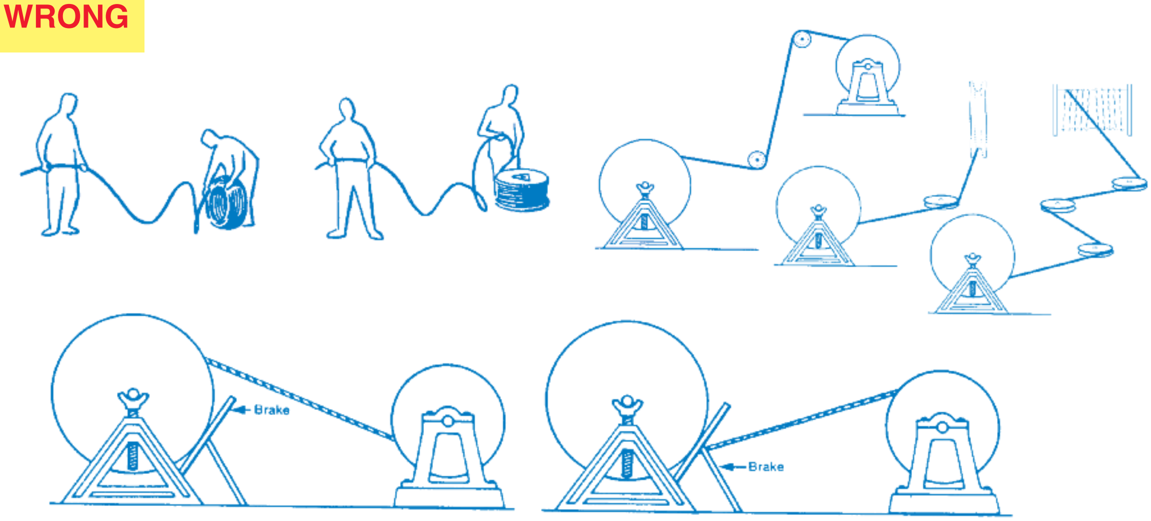
All of these precautions apply to Python® as well as to standard 6-strand-, 19x7, 19x19, and 34x7 wire ropes.

If in doubt, contact your nearest Unirope® representative.

RIGHT



WRONG



Installation of Wire Rope

Connecting the old rope to the new rope

Depending on the type of rope several accepted methods are available.

Welding
Welding two ropes together is common in the steel industry. If properly done, welding may develop sufficient strength to complete the rope installation. However, the welded portion of the rope is rather stiff, and the welded steel wire material may become brittle. Since the welded portion has to pass over sheaves, there is the danger that the weld may break.

If installing Python® wire rope as well as all non-rotating types we do not recommend the welding procedure. Welding might damage the seizing and the rope may unravel getting damaged beyond repair.

Becket Loops
A common method for heavy crane rope installations. A steel sleeve only slightly larger than the rope diameter is swaged on to the rope end and a small auxiliary cable protrudes from the sleeve. Either, the old rope is furnished also with a becket loop, or the old rope will be connected to the becket loop with a cable grip.

Use of Cable Grips

The most common method to install a wire rope. The type of cable grip depends on the rope type and construction.

Non-rotating rope must be installed with a swivel between old and new ropes. The old rope may have developed torque during it's working life and we must ensure that this torque is not transferred to the new rope.

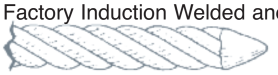
Python® types Multi and Super 8 may be installed with a swivel. In fact, if you have to change either of these constructions for a 6-strand rope, particularly when this rope has a different lay direction, a swivel is of definite benefit.

Python®-Power 9 and Python® Ultra must not be installed with a swivel. Doing so will unlay the rope and damage it beyond repair. Use two cable grips and connect them with an auxiliary cable.

CAUTION

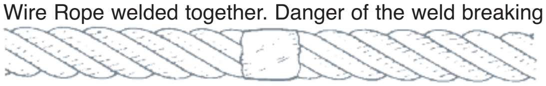
When using cable grips, the end of the grips have to be tightly seized on to the rope body to prevent accidental slip-out of the rope. Alternately, you may wrap the grip end with a strong reinforced industrial strength adhesive tape.

Factory Induction Welded and Tapered End

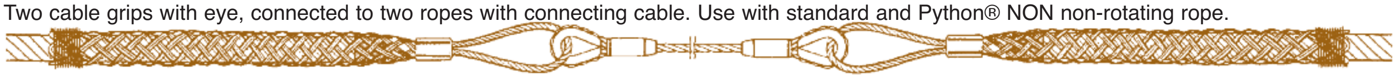


Becket Loop End

Wire Rope welded together. Danger of the weld breaking when bent around sheaves.



Two cable grips with eye, connected to two ropes with connecting cable. Use with standard and Python® NON non-rotating rope.



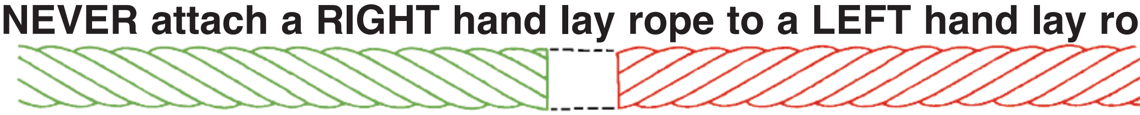
Two cable grips with eye, connected to two ropes with a swivel. Use with non-rotating rope.

One cable grip connected to old rope, becket loop factory installed to new rope.

Open-end cable grip connected to two ropes. Commonly used with a 6-strand rope.

CAUTION

NEVER attach a RIGHT hand lay rope to a LEFT hand lay rope



either welded together or without a swivel between them !

Installation of Wire Rope

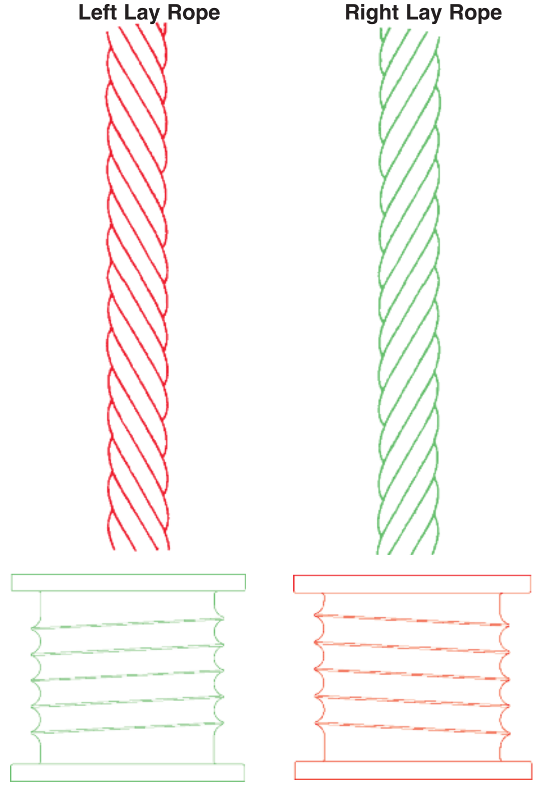
Rope Lay direction versus Drum Grooving

Be sure to use the correct rope lay direction for the drum. This applies to smooth, as well as to grooved drums.

Many crane models have a two sided grooved drum, one part of it is left, the other right lay grooved. Some wire ropes are more sensitive to this type of design than others; it depends on lifting height, frequency of use, and even the rope diameter as to the type of wire rope most suitable for that application.

In some applications it may be advisable to select the rope lay direction according to the most frequently used drum layers (if more than one layer is spooled). If the first rope layer on a drum is used as a 'guide layer' only, it may be advisable to select the rope lay direction according to the second drum layer.

Left Lay Rope **Right Lay Rope**

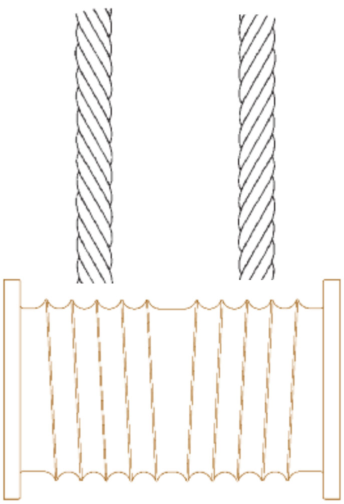


Right Hand Grooved: Use Left Hand Rope

Left Hand Grooved: Use Right Hand Rope

The easiest way to identify correct match between rope and drum is to look alongside the drum axis and the rope axis: the direction of lay/drum groove must be opposite to each other.

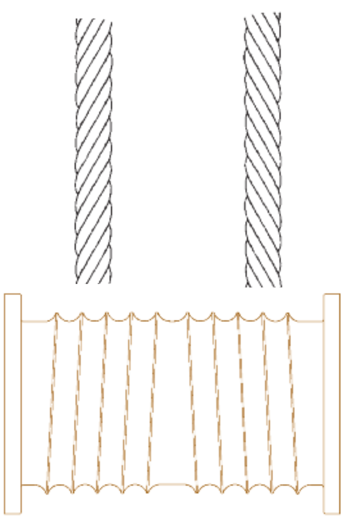
Left Lay Rope **Right Lay Rope**



Right Hand Grooved: Use Left Hand Rope

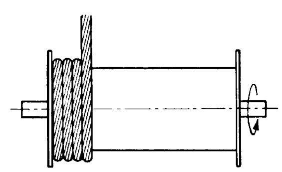
Left Hand Grooved: Use Right Hand Rope

Right Lay Rope **Left Lay Rope**

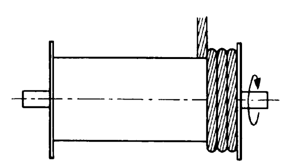


Left Hand Grooved: Use Right Hand Rope

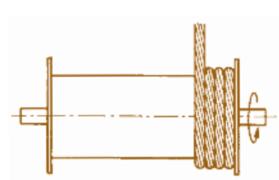
Right Hand Grooved: Use Left Hand Rope



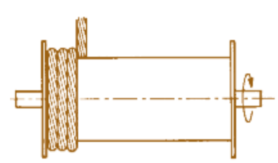
Overwind from right to left: Use Left Hand Rope



Overwind from left to right: Use Right Hand Rope



Underwind from left to right: Use Left Hand Rope



Underwind from right to left: Use Right Hand Rope

Installation of Wire Rope

Winding the rope on to a multiple layer drum system

Winding on smooth or flat faced drums

Start winding the rope in a straight helix angle. To assist with this, some drums have a tapered steel part attached to one flange which 'fills' the gap between the first turn and the flange (see picture 7).

The first layer must be wound tight and under tension. Take a mallet or a piece of wood and tap the wraps tightly against each other (see picture 1); but not so tight that the rope strands interlock (see picture 2), but tight enough that the rope can't be shifted on the drum. If the first layer is wound too loose, the next layer will wedge a gap into the first layer causing that layer to 'pull in' (see picture 3). A too tightly wrapped first layer will not allow the next layers enough space between wraps (see picture 2).

In any case, the first layer, as well as all of the layers, must be wound on to the drum with sufficient pre-tension (5-10% of the rope's WLL is a good measure). If wound with no tension at all, the rope is subjected to premature crushing and flattening caused by the 'under load' top layers (see picture 4)

Even if wound on properly during installation, the first layer will loosen somewhat during service. When the first layer becomes slack (the pre-tension is gone), this initial procedure MUST be repeated in regular intervals.

Otherwise, the tensioned 'hard' wraps will severely crush the bottom layers (picture 5).

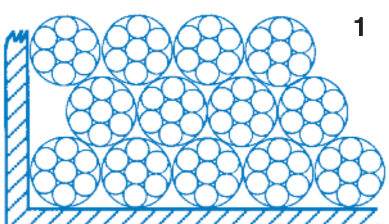
Winding on grooved drums

Basically, follow the same procedure as for smooth drums. Also here, pre-tension is of utmost importance.

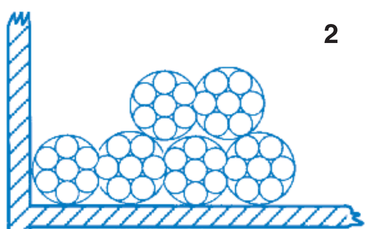
If the first layer, or layers, are only used from time to time, they will loose their tension on the drum and start to flatten out due to the high pressures of the loaded layers. Repeat this pre-tensioning procedure regularly.

As with tower cranes, for example, which have a long rope length installed and rise as the building goes up, pre-tensioning will not be possible. In these cases it may be advisable to install a shorter rope length first. Otherwise, you may have to replace the entire rope length because of crushing and flattening of the bottom layers. If this not possible, extra care must be taken to pre-tension the rope on the drum during installation.

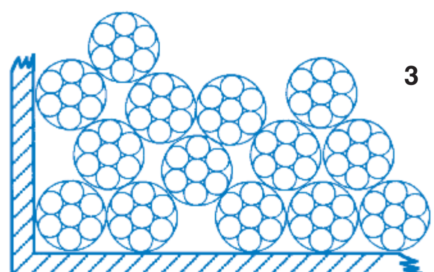
Whatever you do, **DO NOT** run the rope through a 'tightening' device (see picture 6), e.g. two wooden blocks clamped together. YOU WILL DESTROY THE ROPE !



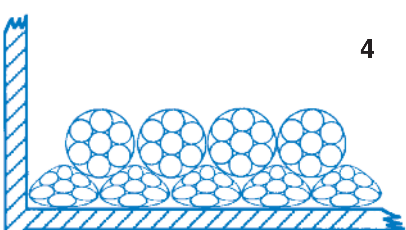
Proper winding on drum. Rope does not interlock and has enough pre-tension not to damage the bottom layers.



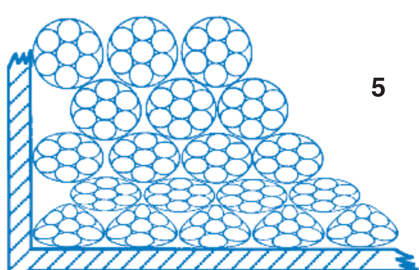
Rope wraps have been tapped too much together. Note the resulting strand interlocking. The rope will get damaged.



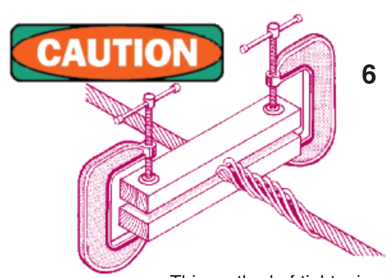
Rope wraps have gaps on first layer. Note that the top layers will not spool properly. The rope "pulls in".



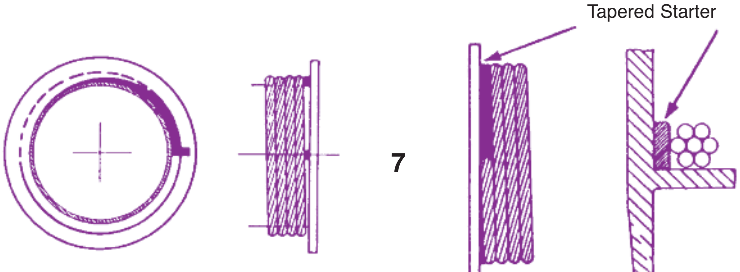
Bottom layer was not wound on the drum with enough tension. This layer will get crushed by the top layer when loaded to WLL.



Layers were not unspooled and pre-tensioned during service. Bottom layers will flatten out by the load imposed by the top windings

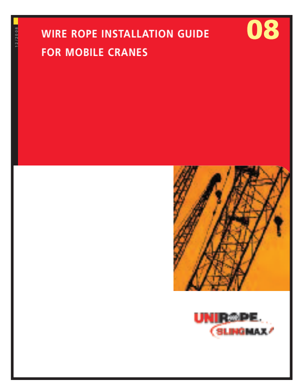


This method of tightening the rope on to the drum WILL destroy the rope.



This tapered lifter provides a ramp for the rope to ride up the flange to prevent wedging the rope against the flange and adjacent wraps.

For further information on wire rope installation onto mobile cranes please refer to our Installation Guide.



Installation of Wire Rope

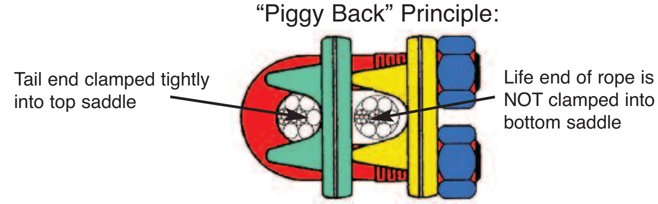
Wedge Sockets

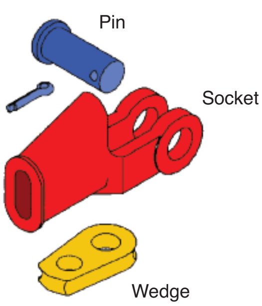
End terminations with wedge sockets are most popular with tower and mobile cranes although they do not generate as high as an strength efficiency rating as swaged sleeves, swaged sockets, or spelter sockets. Depending on rope construction and type, their efficiency rating ranges between 75% and 80%. For detailed information ask the manufacturer of your wedge socket.

The installation of Python rope into wedge sockets is similar to that of 6- or 8-strand wire rope. Here's a quick run down of some of the do's and dont's:

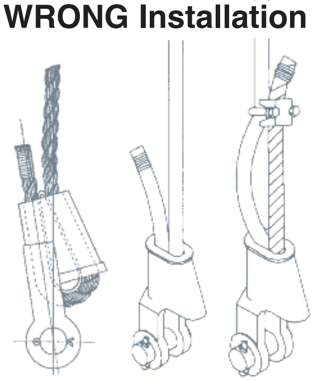
- Always inspect socket, wedge and pin before installation.
- For intermediate rope sizes use next larger socket size (e.g. use a 3/4" socket for a 18 mm rope)
- Align live end of rope with center line of pin.
- Use a hammer to seat Wedge and rope as deep into the socket as possible.
- Apply first load to fully seat the wedge and wire rope in the socket.
- Ensure that the rope end is welded and/or properly seized before inserting the rope into the socket. Failing to do so may cause the core to slip and/or the strands to loosen inflicting serious rope damage.
- The tail length should be a minimum of 6 x rope diameter but NOT less than 6 inches.
- Secure the dead end section of the rope. Several accepted methods are available and illustrated on this page.
- **DO NOT CLAMP OR CLIP THE DEAD END OF THE ROPE TO THE LIVE END.**
- During use, do not strike the dead end section with any other elements of the rigging (called Two-Blocking).
- When using with 34x7 and all Python non-rotating types attach a hose clamp approx. 3-5 ft above the socket to the **LIVE END** of the rope **BEFORE ATTACHING THE SOCKET**. The clamp will prevent any looseness of the outer strands, which may have occurred during installation, from travelling along the entire rope length. If this happens you have to shorten the rope slightly but you will have contained the damaged zone to a very short rope portion.

"Piggy Back" Principle:

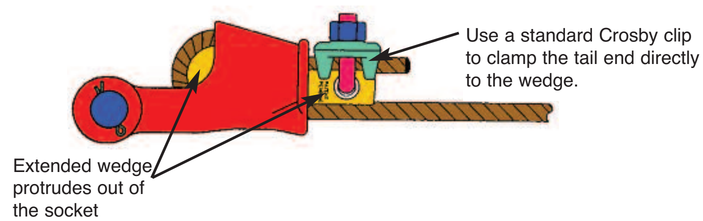




WRONG Installation

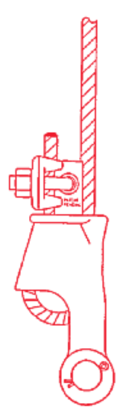


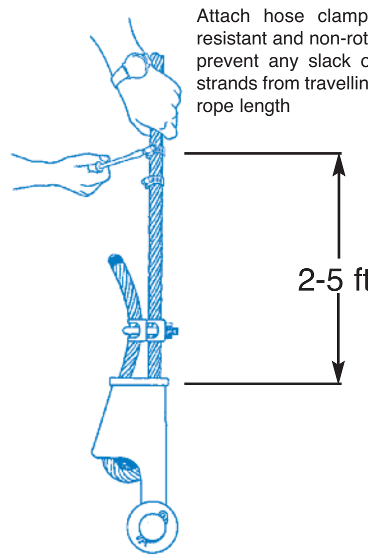
Crosby "Terminator™" Principle:



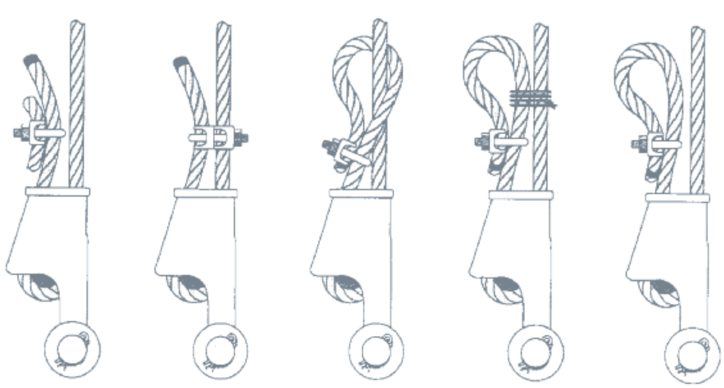
Non-Rotating Ropes

Attach hose clamp to all rotation-resistant and non-rotating wire rope to prevent any slack of outer- or inner strands from travelling along the entire rope length





Accepted Methods



CAUTION **Never use a wedge made by a different manufacturer than the socket. Use only original spare parts.**

Installation of Wire Rope

Using Your rope for the first time

Break In Period

After installing a new rope it is necessary to run it through its operating cycle several times under light load and at reduced speed. This allows the rope to adjust itself to the working conditions and enable all strands and wires to become seated. Depending on rope type and construction some rope stretch and a slight reduction in rope diameter will occur as the strands and core are compacted. The rope is less liable to be damaged when full load is applied.

The initial stretch (constructional stretch) is a permanent elongation that takes place due to slight lengthening of the rope lay and due to a slight decrease in rope diameter. Constructional stretch generally takes place during the first 10-20 lifts, and increases the rope length by between 1/2% for fiber core rope, approx. 1/4% for 6-strand steel core rope, and approaches zero for compacted Python ropes

I you have the chance and the equipment configuration allows this, disconnect the rope end after the break-in-period to allow any possible torque and twists which may have developed during installation and the break-in-period to be released at the end connection.

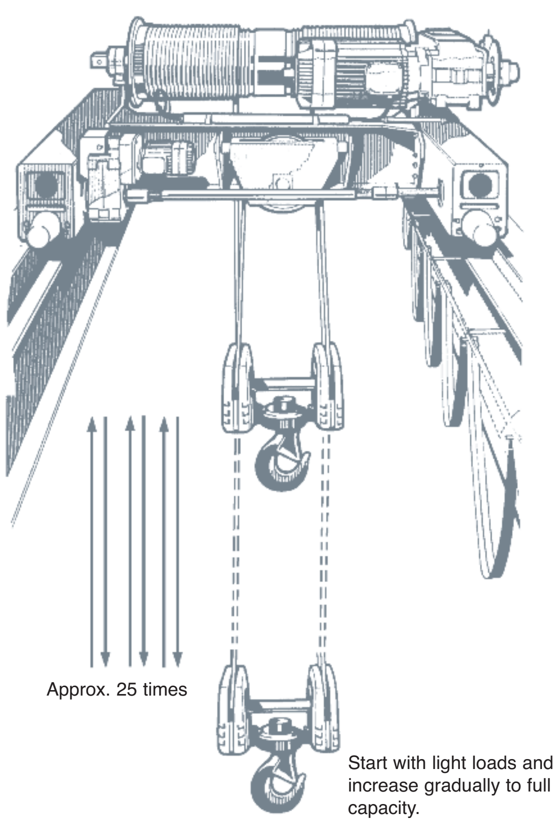
Equipment Testing

In many cases the crane equipment has to be tested prior to use. Proof testing requires to purposely overload the crane to varying degrees. The magnitude of overloading depends on the type and capacity of the crane and which governing authority certifies the equipment. The test may impose an overload of between 10% and 100% of the crane's rated capacity.

Under **NO** circumstances must the crane be tested prior to the break in procedure of the wire rope. If you overload a rope which has not yet been broken in, you may inflict permanent damage to the rope.

Equipment with multiple layer windings call for additional caution. As mentioned before, severe overloads of the top layers may damage the lower ones or may crush the rope. If possible, test the crane with the rope spooled in the first drum layer only.

If the crane is equipped with a smooth drum, special care must be taken to ensure that the rope does not cross-wind over itself when testing the crane. After testing (overloading) you have to repeat the spooling procedure as outlined on page -10- 'Winding on smooth or flat faced drums'.



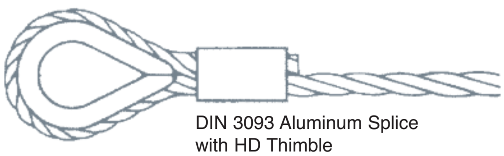
End Terminations

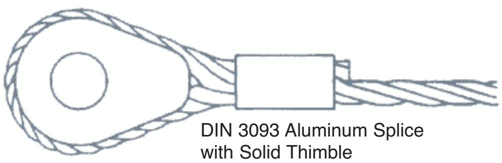
Efficiency Ratings

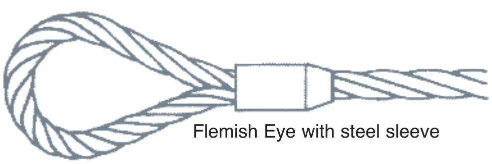
This page lists several types of end terminations used for overhead lifting applications.

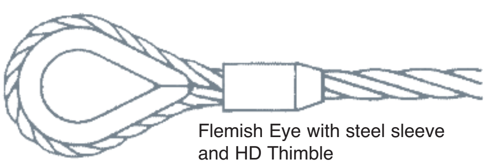
All efficiency ratings are based on the difference between the actual breaking strength of a rope and the attained breaking strength with that specific fittings. The only fitting which will attain a 100% efficiency are spelter sockets; provided they are properly attached.

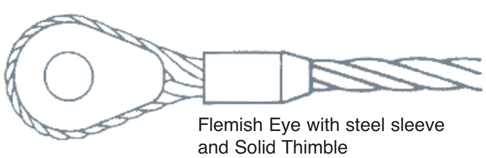
ALL other fittings are swaged or clamped onto the rope. The swaging or clamping process compresses the rope to varying degrees causing a slight loss of strength. Some publications refer to '100%' efficiency with swaged sockets. Bear in mind, that most wire ropes have an actual breaking strength up to approximately 5%-15% HIGHER than the breaking strength listed in catalogue tables. With other words: a fitting having an efficiency rating of 90% may very well develop 100% of the rope's CATALOGUE breaking strength because the rope's ACTUAL breaking may very well be 5%-15% higher.

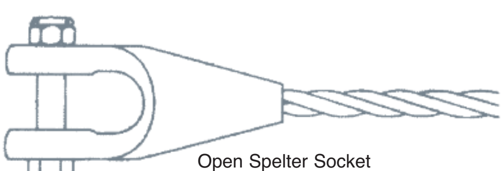
(2)

DIN 3093 Aluminum Splice
with HD Thimble
90%

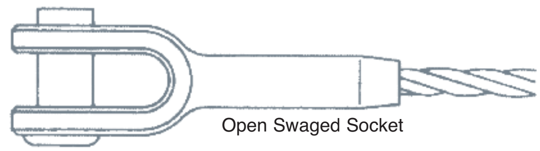
(2)

DIN 3093 Aluminum Splice
with Solid Thimble
90%

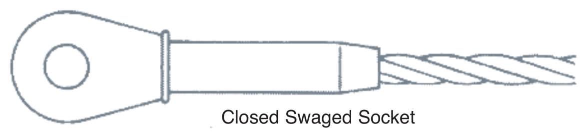
(1)

Flemish Eye with steel sleeve
87% to 96%

(1)

Flemish Eye with steel sleeve
and HD Thimble
87% to 96%

(1)

Flemish Eye with steel sleeve
and Solid Thimble
87% to 96%


Open Spelter Socket
(Closed no shown)
100%


Open Swaged Socket
90%


Closed Swaged Socket
90%

(3)

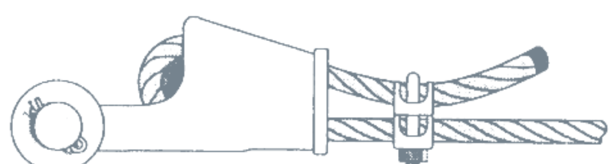
UNI-LOC™ Button
90%

(3)

UNI-LOC™ Threaded Stud
90%

(1)

Forged Wire Rope Clips
80%


Wedge Socket
75% - 80%

(1) Use only with 6-strand wire rope. Efficiency rating depends on rope size and core type.

(2) Meets EN13411

(3) Fabrication efficiency depends on fitting dimensions. Ask for information on UNI-LOC™ Assemblies.

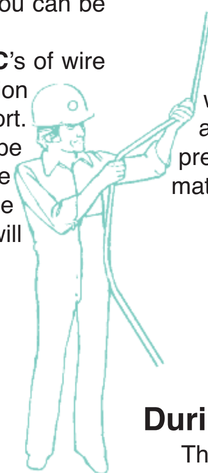
Inspection of Wire Rope

General

It is essential to maintain a well planed program of periodic inspections. In most cases there are statutory and/or regulatory agencies whose requirements must be adhered to. Whether or not such requirements exist in your specific environment, you can be guided by the suggested procedures that follows.

Abrasion, **B**ending and **C**rushing represent the **ABC**'s of wire rope abuse, and it is the primary goal of good inspection practice to discover such conditions with minimum effort. When any degradation indicates a loss of original rope strength, a decision must be made quickly to allow the rope to remain in service. Such a decision can only be made by an experienced inspector. His determination will be based on:

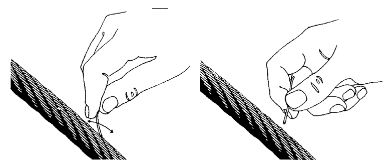
1) Details of the equipment's operation
2) Frequency of inspection
3) Maintenance history
4) Consequences of failure
5) Historical records of similar equipment



Broken Wires

Shortly after installation

The occasional premature failure of a single wire may be found early in the rope life and in most cases it should not constitute a basis for rope removal. Note the area and watch carefully for any further wire breaks. Remove the broken ends by bending the wire backwards and forwards. In this way the wire is more likely to break inside the rope where the ends are left tucked away between the strands. These infrequent premature wire breaks are not caused by fatigue of the wire material.

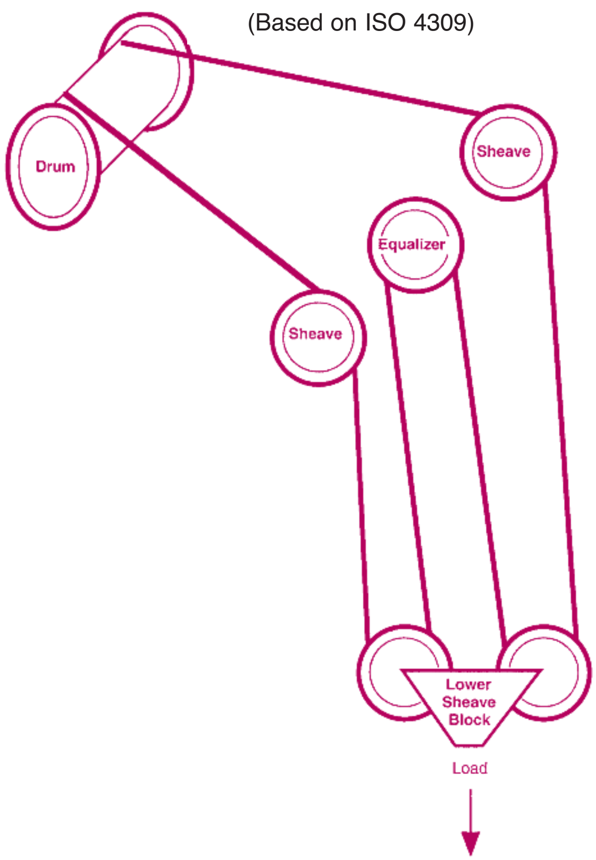


During wire rope service (Fatigue Breaks)

The rope must be replaced if a certain number of broken wires are found which indicate that the rope has reached its finite fatigue life span. See pages tables next page.

Areas to examine

(Based on ISO 4309)



1)
Examine termination of the rope.

2)
Examine for defective coiling, which causes deformation (flattened portions) and wear, which can be severe at cross-over positions. (cross-overs only if multiple layer drums)

3)
Examine for wire breaks.

4)
Examine for corrosion.

5)
Look for deformations caused by snatch loading.

6)
Examine portion which winds over sheave for wire breaks and wear.

7)
Check section of rope on equalizer sheave (or compensating pulley)by lifting up the rope to look at the underside.

8)
Look for deformation.

9)
Check rope diameter against original wire rope diameter. Keep record of rope diameter measured after break in period. Note that shortly after installation rope diameter will slightly decrease.

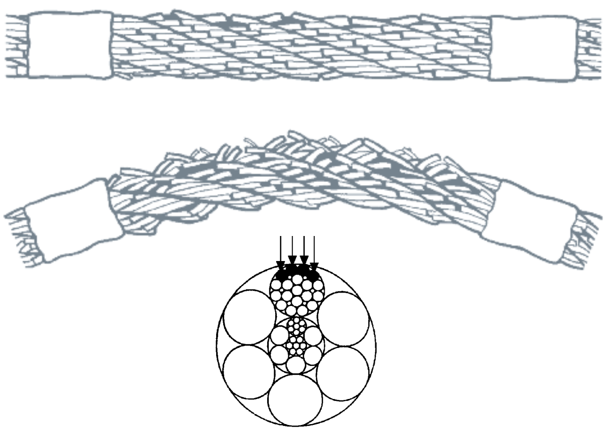
10)
Examine carefully length which runs through lower sheave block, particularly that section which is in contact with the pulley when the crane is in a loaded condition.

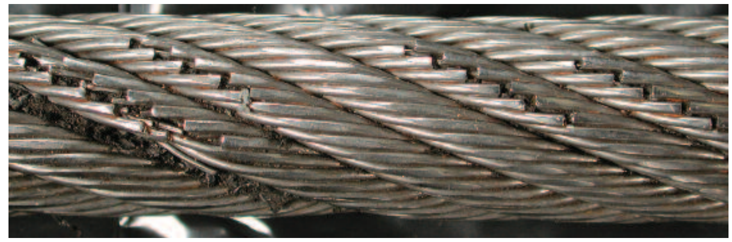
11)
Examine for wire breaks or surface wear.

Inspection of Wire Rope

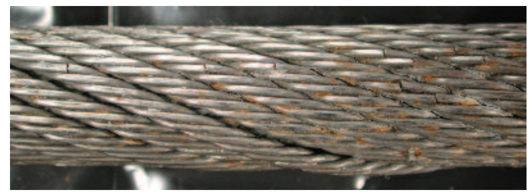
Under normal operating conditions single wires will break due to material fatigue on the CROWN of a strand.
ALL wire rope removal/retirement criteria are based on FATIGUE wire breaks located at the CROWN of a strand.
Tables see next page.

CROWN Fatigue Wire Breaks





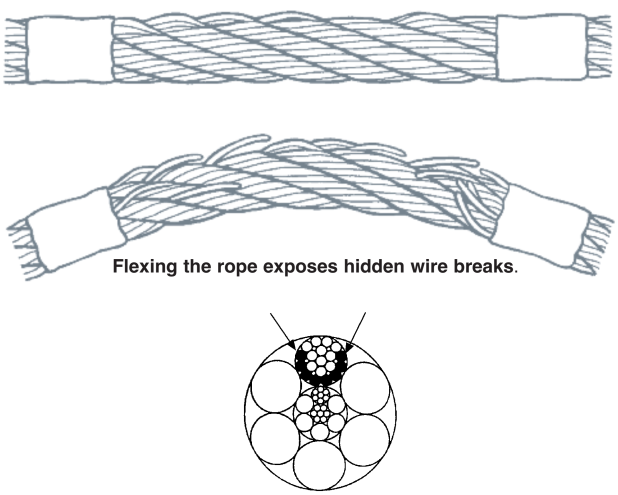
Example: Severe crown wire breaks on a 10-strand overhead crane wire rope. Crown breaks originate at the OUTSIDE of the rope at the contact point between rope and sheave/drum.



Crown wire breaks on a Python® Lift non-rotating wire rope

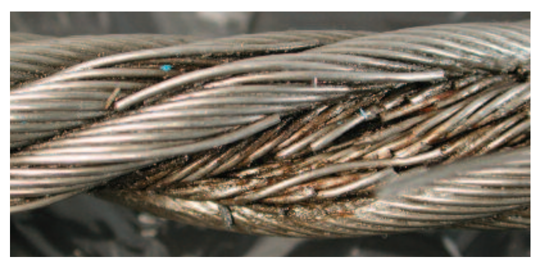
Remove wire rope from service if even if you detect a SINGLE valley wire break ONLY.
Valley breaks hide internal wire failures at the core or at the contact between strand and core.

VALLEY Wire Breaks



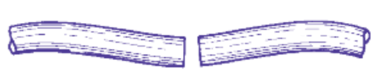
Example: Valley wire breaks on a 8-strand overhead crane wire rope

Valley breaks originate INSIDE the rope. Condition of the inner strands of the same rope as above. The core has completely failed and imminent catastrophic rope failure will be the result.

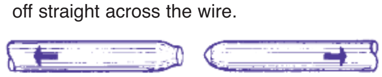


A single valley wire break on a 19x7 rotation resistant rope.

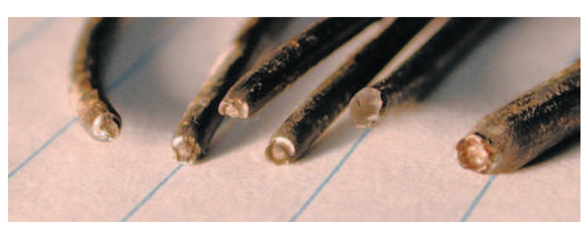
Condition of core under that same single valley break. Note the extreme notching of individual wire and the countless wire breaks. Such a condition is hidden under just a single (1) valley break !



FATIGUE wire breaks are typically squared off straight across the wire.



TENSILE wire breaks are characterized by their typical *'cup and cone'* appearance.



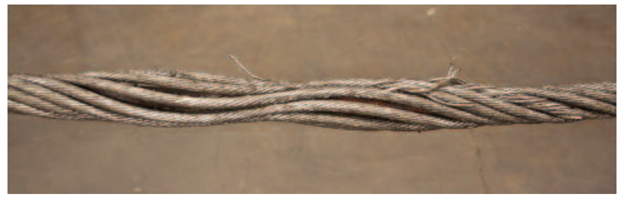
On the right and left a typical cut -and-cone break pattern. The wires in the center of the photo are a combination of fatigue and shear break.

NOTE: For a more indepth discussion on wire rope discard and inspection we suggest to attend our "Wire Rope" and "SlingMax® Rigger's Mortis Seminar". Call 1.800.457.9997 for details and dates.

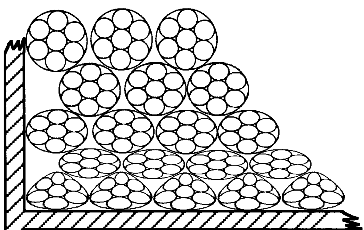
Inspection of Wire Rope

Damages caused by connection a right hand to a left hand lay rope

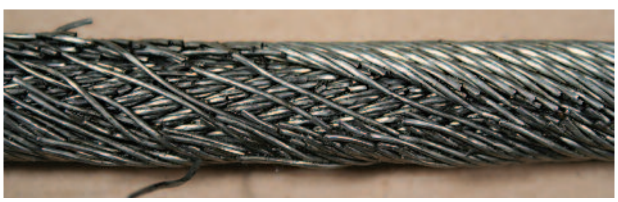
These 3 picture show what happens when you connect a left-lay rope to a right-lay rope, as done with this boom pendant extension. Both ropes are opening up to the point where the strands are nearly parallel to each other; they completely untwisted themselves and developed excessive wire breaks.



Damages caused by multiple layer winding



This is what happens when spooling on multiple layer drums was not properly tensioned.



The result of such non-tensioning of the layers are looping of individual wires, completely crushed strands, total deterioration of a non-rotating rope due to gross neglect of inspection procedure.

All removal criteria are based on the use of steel sheave.

			Running Ropes* Number of allowable broken wires in		**Rotation Resistant*** Number of allowable broken wires in		**Standing Ropes*** Number of allowable broken wires	
Standard	Version	**Equipment**	one rope lay	one strand in one lay	6 x rope dia.	30 x rope dia.	in one lay	at end connection
ASME B30.2	2011	Overhead and Gantry Cranes	12	4	-	-	-	-
ASME B30.3	2012	Tower Cranes	12	4	2	4	-	-
ASME B30.4	2010	Portal and Pedestal Cranes	6	3	4 See below	2	-	2
ASME B30.5	2011	Mobile and Locomotive Cranes	6	3	2	4	-	2
ASME B30.6	2010	Derricks	6	3	Consult rope manufacturer		3	2
ASME B30.7	2011	Winches	6	3	6	4	3	2
ASME B30.8	2010	Floating Cranes and Derricks	6	3	-	4	3	2
ASME B30.16	2007	Overhead Hoists (Underhung)	12	4	2	4	-	-
ASME B30.29	2012	Self Erecting Tower Cranes	6	3	2	4	3	2
					4 in one lay	2 in one strand in one lay		

*) Also remove if you detect one (1) wire broken at the contact point with the core or adjacent strand; so called 'valley' breaks.

Regular single-layer and parallel type (e.g. DoPar®) Wire Rope

Reference: ISO 4309:2010

Number of wire breaks, reached or exceeded, of visible broken wires

Number of load bearing wires in outer strands[a]	Examples of rope constructions and types	Number of visible broken wires[b]					
		Sections of rope working in steel sheaves and/or spooling on a single layer drum (wire breaks ramdomly distributed)				Sections of rope spooling on a multiple-layer drum[c]	
		Classes M1 to M4 or class unknown[d]				All Classes	
		Regular Lay		Langs Lay		Regular and Langs Lay	
		Over a length of 6xd[e]	Over a length of 30xd[e]	Over a length of 6xd[e]	Over a length of 30xd[e]	Over a length of 6xd[e]	Over a length of 30xd[e]
under 50	6x7, 7x7	2	4	1	2	4	8
51 to 75	6x19 Seale*	3	6	2	3	6	12
76 to 100		4	8	2	4	8	16
101 to 120	6x26, 6x25, 8x19 Seale	5	10	2	5	10	19
121 to 140		6	11	3	6	11	22
141 to 160	8x19Filler, Python® Super 8	6	13	3	6	13	26
161 to 180	6x36*, Python® Power 9	7	14	4	7	14	29
181 to 200	Python® Multi, Ultra	8	16	4	8	16	32
201 to 220	6x41*	9	18	4	9	18	38
221 to 240		10	19	5	10	19	38
241 to 260	8x36*	10	21	5	10	21	42
261 to 280		11	22	6	11	22	45
281 to 300		12	24	6	12	24	48
300 and over		0.04n	0.08n	0.02n	0.04n	0.08n	0.16n

Ropes having outer strands of Seale construction where the number of wires in each strand is 19 or less (e.g. 6x19 Seale) are placed in this table two rows **above** that row in which the construction would normally be placed based on the number of load bearing wires in the outer layer of strands.

[a] Filler wires are not regarded as load-bearing wires and are not included in the number of total wires in the outer strands.

[b] A broken wire has two ends (counted as one wire break)

[c] The discard criteria for ropes spooling on to multiple layer drums applies to deterioration that occurs at the cross-over zones and interference between wraps due to fleet angle effects and NOT to sections of rope which only work in sheaves and do NOT spool onto the drum.

[d] Twice the number of broken wires listed may be applied to ropes on mechanisms whose ISO classification is known to be M5 to M8

[e] d = nominal rope diameter

Rotation-Resistant and Non-Rotating Wire Rope or Category I, and II according to ASTM 1023

Reference: ISO 4309:2010

Number of wire breaks, reached or exceeded, of visible broken wires

Number of load bearing wires in outer strands[a]	Examples of rope constructions and types	Number of visible broken wires[b]			
		Sections of rope working in steel sheaves and/or spooling on a single layer drum (wire breaks ramdomly distributed)		Sections of rope spooling on a multiple-layer drum[c]	
		All Classes		All Classes	
		Over a length of 6xd[d]	Over a length of 30xd[d]	Over a length of 6xd[d]	Over a length of 30xd[d]
4 strands ≤ 100	4x29F	2	4	2	4
3 or 4 strands ≥ 100	4x26 WS, K3x40	2	4	4	8
At least 11 outer strands					
71 to 100	19x7	2	4	4	8
101 to 120	35x7	3	5	5	10
121 to 140	39x7	3	5	6	11
141 to 160		3	6	6	13
161 to 180		4	7	7	14
181 to 200	19x19S	4	8	8	16
201 to 220		4	9	9	18
221 to 240	35x17S	5	10	10	19
241 to 260		5	10	10	21
261 to 280		6	11	11	22
281 to 300		6	12	12	24
300 and over	35x31WS, 35x25F, 35x19W	6	12	12	24

Ropes having outer strands of Seale construction where the number of wires in each strand is 19 or less (e.g. 6x19 Seale) are placed in this table two rows **above** that row in which the construction would normally be placed based on the number of load bearing wires in the outer layer of strands.

[a] Filler wires are not regarded as load-bearing wires and are not included in the number of total wires in the outer strands.

[b] A broken wire has two ends (counted as one wire break)

[c] The discard criteria for ropes spooling on to multiple layer drums applies to deterioration that occurs at the cross-over zones and interference between wraps due to fleet angle effects and NOT to sections of rope which only work in sheaves and do NOT spool onto the drum.

[d] d = nominal rope diameter

Inspection of Wire Rope

Worn and abraided wires

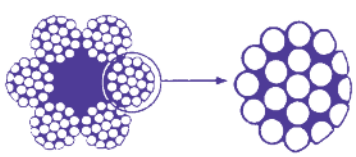
Wear, due to friction on sheaves, rollers, drums, etc., eventually causes outer wire abrasion.

Before any inspection is made, determine what type of wire rope you have in service. Many of today's wire ropes are 'compacted', 'calibrated, or 'die formed'. This manufacturing process purposely flattens the outer wires and for an inexperienced inspector these ropes may appear to be already abraded when indeed they are brand new. If you are in doubt about what type of rope you are about to inspect, have a look at a section of the rope which was not subjected to any abrasive work; e.g. like the safety wraps on the drum or a section just behind the end connection.

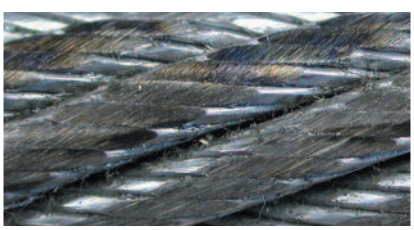
The round outer wires of standard wire rope will become flat on the outside due to friction when in contact with drums, sheaves, or other abrasive matter like sand or gravel. This is part of normal service deterioration and in most crane installations relatively even abrasion will occur. **The rope must be replaced, however, if this wear exceeds 1/3 of the diameter of the wire.**

It is good practice to compare a section of the rope which was NOT subjected to any bending work (e.g. the safety wraps, or a short section behind the end fitting) to the rope section to be inspected.

The same applies when evaluating any possible reduced rope diameter during service. (See next column)



When the surface wires are worn by 1/3 or more of their diameter the rope must be replaced.



Abrasion caused by dragging the rope over a sharp object (steel corner, sharp plate, abrasive surface etc.)

Peening and subsequent wire break caused by high fleet angle and rope vibration.

Rope abrasion caused by normal operating condition on a high cycle crane. Rope must be retired.

Reduction in wire rope diameter

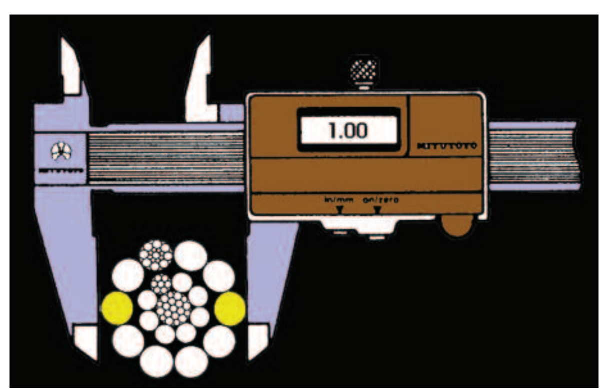
As already discussed on page -5- 'Measuring the rope diameter' and on page -12- 'Break-In-Period' shortly after installation the wire rope diameter will slightly decrease. This is normal and is caused by the adjustment of all rope elements when loaded the first time. To evaluate the diameter reduction, you have to measure the rope when new, and you also have to measure the rope after the break in period at a specified load. This gives you a good indication of the magnitude of the initial diameter reduction in your specific application. The diameter reading you took after the break in period should now become your 'gauge'. Do not compare the rope diameter you are about to take with the 'catalogue' diameter. It may give you a false indication, since wire rope may have a plus tolerance of up to 4% to 5% over the 'catalogue' diameter.

If you detect a further diameter reduction when measuring the rope under the same load condition as after the break in period, it is often due to excessive abrasion of the outside wires, loss of core support, internal or external corrosion, inner wire failures, and/or inner wire abrasion. However, there will always be a normal continuous small decrease in diameter throughout the rope's service life.

Core deterioration, when it occurs, is revealed by a more rapid reduction in diameter, and when observed, it is time for removal.

Deciding whether or not a rope is safe is not always a simple matter. A number of different but interrelated conditions must be evaluated. It would be dangerously unwise for an inspector to declare a rope 'safe' for continued service simply because its diameter had not reached a certain minimum diameter if, at the same time, other observations led to a different conclusion.

However, ASME, ISO 4309, CSA, other Canadian Provincial H&SA and USA OSHA Regulation have various values published for maximum allowable diameter reductions. They are somewhat confusing as they show diameter reduction values from 3.5% to 9%, and some give reduction values in inch fractions depending on rope nominal diameter.



Take measurement of rope diameter AFTER the Break In Period.

Inspection of Wire Rope

Rope Stretch

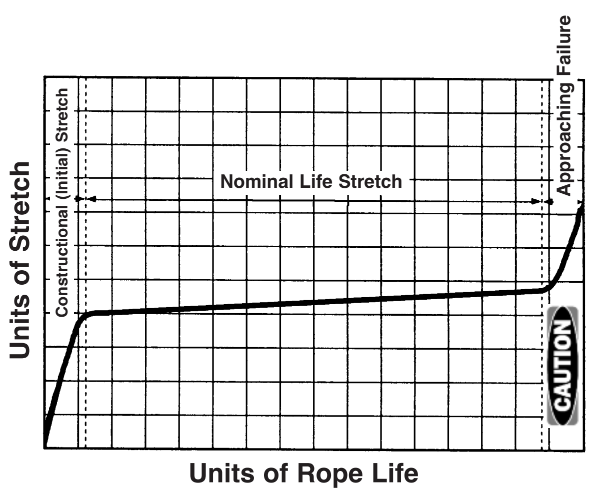
Constructional Stretch

All ropes will stretch to varying degrees when loads are initially applied. This stretch is known as the ‘constructional stretch’ (see also: page -12- Run-In Period)
This stretch occurs in three phases:

1) Initial or constructional stretch during the early period (Run-In) of rope service, caused by the rope adjusting to the operating conditions.

2) Following the run-in period there there is a extended period -the longest part of the ropes’s service life- during which a slight increase in stretch takes place over an extended time. This results from normal wear, fatigue etc. On a graph this portion would almost be a horizontal straight line inclined slightly upward from its initial level.

3) Thereafter, the stretch occurs at a quicker rate. This means that the rope has reached the point of rapid degradation; a result of prolonged subjection to abrasive wear, fatigue, and inner undetected wire breaks, etc. This second upturn of the curve is a warning indicating that the rope should be removed to avoid sudden catastrophic rope failures.



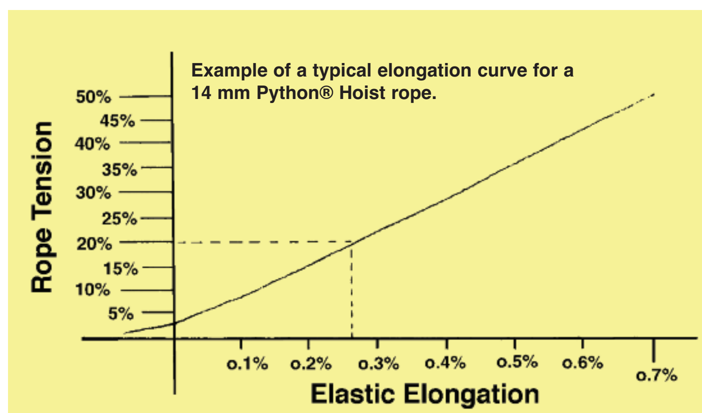
Elastic Stretch / Elastic Limit

Elastic stretch of wire rope occurs as soon as a load is applied. When the load is released the rope returns to it’s initial length, hence the term ‘elastic’ stretch. This stretch is caused by the elastic deformation of the steel itself (the individual steel wires) and also by the lay of the rope which could be compared to resemble a coil spring. With other words, the longer the lay length of a rope becomes, the less elastic stretch it will develop. Elastic stretch in a wire rope is a desired feature. The ability of a rope to stretch under load means that the rope is capable to absorb energy; the term here is ‘energy absorption capability’.

In many instances it is not easy to clearly distinguish between (the remains of) constructional stretch and elastic stretch as they may occur together especially when the rope is new.

The values for Elastic Stretch are dependent on rope construction, lay length and type, steel material, tensile strength of wires etc. An approximation is 0.25% to 0.6% at WLL (or lifting capacity). The E-module varies similarly from about 11 Million to 16 Million lbs/inch^2. For exact values please contact us for further information.

Elastic stretch turns into a ‘permanent’ stretch when the rope is loaded beyond 55%-60% of it’s breaking strength (or beyond 2-1/2 to 3 times its WLL). At that point the steel material elongates and deforms permanently and renders the rope inoperable as the individual wires will have lost much of their mechanical properties to withstand material fatigue.



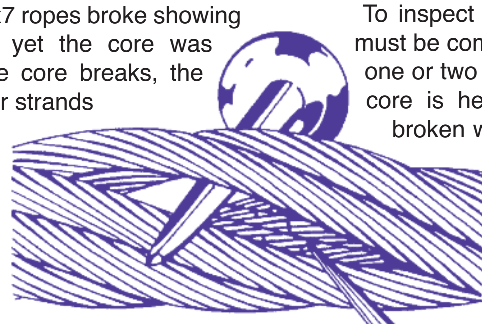
Core Wire Breaks

The most difficult to detect wire rope deterioration. Core wire breaks are more likely to appear in 6 & 8-strand and 19x7/19x19 ropes, rather than in multi-strand plastic coated core wire rope. We have had examples where 8x36 and 19x7 ropes broke showing no externally visible removal criteria, yet the core was completely broken to pieces. Once the core breaks, the resultant sudden shock load on the outer strands may cause the rope to fail in a catastrophic, unpredictable manner.

Core wire breaks in PYTHON™ plastic coated core ropes are not likely to appear due to the cushioning effect of the plastic layer. Field experience from customer returned plastic coated core PYTHON rope revealed no broken core wires without the outer strands having visible wire breaks in excessive numbers far beyond any removal criteria.

To inspect the core of a 6- or 8-strand wire rope, the rope must be completely unloaded. Carefully insert a spike through one or two strands and turn the spike with the rope lay. If the core is heavily lubricated you need good lighting to see broken wires ! You may also wish to use a air gun to blow excessive lubricant off the core, but be sure to re-lube the core after your inspection.

As with any rotation resistant or non-rotating rope we recommend to leave such internal inspections to the expert as such inspections can permanently damage the rope.



Inspection of a 6-strand wire rope

Inspection of Wire Rope

Mechanical Damages

It is nearly impossible to list all variations of mechanical damage a rope might be subjected to. Therefore, the following list should only be taken as a guideline. None of these damages are repairable. However, the magnitude of the damages may vary from a slight cosmetic damage to total destruction of the wire rope. If you are not sure about the extent of the damage, change the rope, or call us for technical assistance and advice.

Bird Cage (6-strand rope) caused by shock loading.

Bird Cage (non-rotating rope) caused by worn sheave grooves.

Bird Cage forced through a tight sheave.

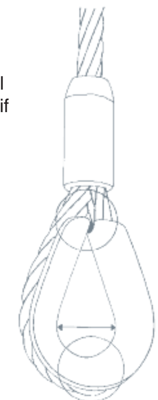
Protruding Core because of shock loading, torque build-up during installation, tight sheaves, or incorrect rope design.

Actual example of a wire rope which jumped out of the sheave. Note the imprint of the sheave flange.

Fittings

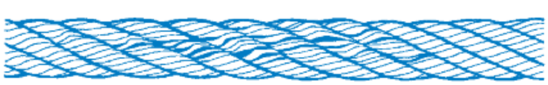
Inspect the fittings on your rope and look for wire breaks at the shank of sockets or sleeves. Inspect the fittings for wear, distortion, cracks, and corrosion. Follow the inspection criteria of the fitting manufacturer and DO NOT ATTEMPT TO REPAIR ANY WIRE ROPE FITTING YOURSELF ! Watch for missing hook latches and install new ones if necessary. If latches wear out too rapidly, ask us for special Heavy Duty latches which may fit your hook. Some hook manufacturers offer self-locking and special Gate Latch hooks.

Inspect wire rope at all fittings. Replace fitting if any broken wires are detected.

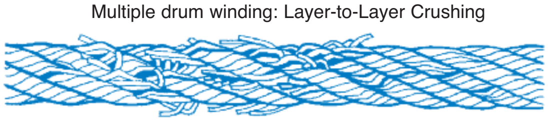


Actual example of a rotation resistant wire rope which was forced to run in too tight sheave grooves. Result is so called ‘core popping’.

Wire rope rolled off a sheave



Multiple drum winding: Layer-to-Layer Crushing



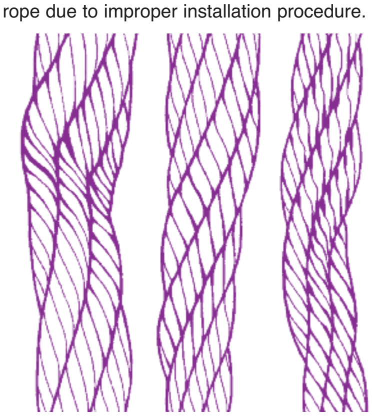
Smooth drum winding: Rubbing between drumwraps

Smooth drum winding: Crushing at Crossover Points

Kinks

Kinked wire rope due to improper installation procedure.

Kinked wire ropes which have been used. Kinks are pulled tight and caused distortion and failure.



Inspection of Wire Rope

Corrosion

Corrosion, while difficult to evaluate, is a more serious cause of degradation than abrasion. Usually, it signifies a lack of lubrication. Corrosion will often occur internally before there is any visible external evidence on the rope surface.

This is one of the reasons why we developed PYTHON™ wire rope with a plastic protected core. The plastic protects the core against corrosion and the user does not have to worry about undetected corrosion which may lead to a sudden and unexpected rope failure.

Corrosion of the rope core not only attack the metal wires, but also prevents the rope's component parts from moving smoothly as it flexes.

Severe rusting leads to premature fatigue failure of single wires. When the rope shows more than one wire failure near a fitting, it should be removed immediately. To prevent abnormal corrosion, the rope should be kept well lubricated. In situations where abnormal corrosive action can occur, it may be necessary to use galvanized or stainless steel wire rope.

Rope Removal and Possible Cause

Fault	Possible Cause
Accelerated Wear	Severe abrasion from being dragged over the ground or obstructions. Rope not suitable for application. Poorly aligned sheaves. Large fleet angle. Worn sheave with improper groove, size or shape. Sheaves and rollers have rough wear surface. Stiff or seized sheave bearings. High bearing and contact pressures. Sheaves/drum too small
Rapid Appearance of Broken Wires	Rope not suitable for application Reverse bends. Sheaves/drums too small. Overload and shock loads. Excessive rope vibration. Kinks that have formed and have been straightened out. Crushing and flattening of the rope. Sheave wobble.
Corrosion	Inadequate lubrication. Improper storage. Exposure to acids or alkalis.
Kinks	Improper installation. Improper handling. Slack rope pulled tight.
Excessive Localized Wear	Drumcrushing. Equalizer Sheave. Vibration.

Fault	Possible Cause
Stretch	Overload. Passed normal stretch and approaches failure.
Broken Wires Near Fitting	Rope Vibration. Fittings get pulled too close to sheave or drum.
Sheaves/Drums Wear Out	Material too soft.
Pinching, Crushing Oval Shape	Sheaves grooves too small. Not following proper installation and maintenance procedure on multiple layer drums.
Rope Unlays (Opens up)	Wrong rope construction. Rope end attached to swivel.
Reduction in Diameter	Broken core. Overload. Internal wear. Corrosion.
Bird Cage	Tight sheaves. Rope is forced to rotate around its own axis. Shock loads. Improper Wedge Socket installation.
Core Protrusion	Shock loading. Disturbed rope lay. Rope unlays. Load spins and rotates rope around its own axis.

Inspection of Sheaves and Drums

Inspection

Proper maintenance of the equipment on which the ropes operate has an important bearing on rope life. Worn grooves, poor alignment of sheaves and worn parts resulting in shock loads and excessive vibration will have a deteriorating effect.

Sheaves should be checked periodically for wear in the grooves which may cause pinching, abrasion, and bird-caging of the rope. If the groove shows signs of rope imprints the sheave must be replaced or re-machined and re-hardened. The same should be done on drums showing similar effect.

Poor alignment of sheaves will result in rope wear and wear on the sheave flange. This should be corrected immediately.

Excessive wear in the sheave bearings can cause rope fatigue from vibration.

Large fleet angles will cause severe abrasion of the rope as it winds onto the drum. Furthermore, the rope will roll into the sheave groove introducing torque and twist which may cause high stranding and bird-cages.

Dimension of the Groove Radius

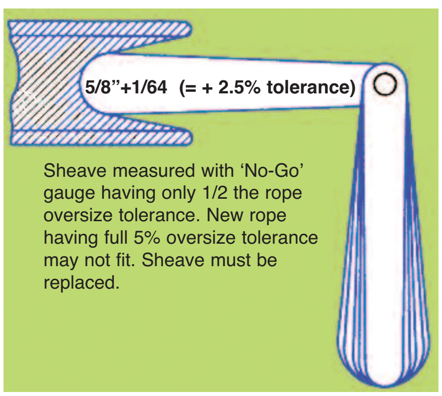
The very first item to be checked when examining sheaves and drums, is the condition of the grooves. To check size, contour and amount of wear, a groove gauge is used.

Two types of groove gauges are in general use and it is important to note which of these is being used. The two differ in their percentage over the Nominal Rope Diameter.

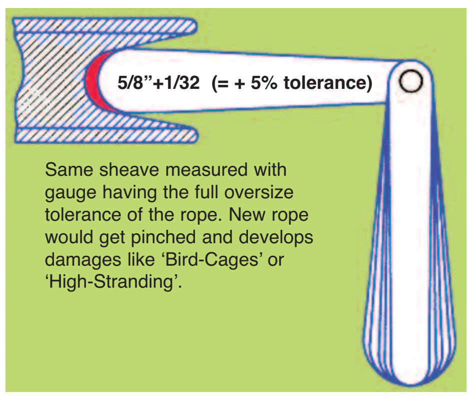
For new or remachined grooves, and for inspection of fitness for new ropes, the groove gauge should be 1% over the maximum allowable Plus Tolerance of the new rope; alternately, the sheave groove must measure 1% over the Actual Rope Diameter intended to be installed.

Many groove gauges on the market are so called ‘No-Go’ gauges and are made with Nominal plus 1/2 of permissible rope Plus Tolerance. If you use these gauges be sure that the existing rope is SMALLER than this gauge. A rope operating in an even slightly undersized groove, deteriorates faster and may develop bird-cages.

(see page -22- for details on groove dimensions)

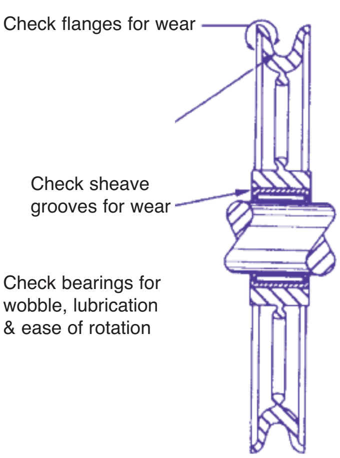


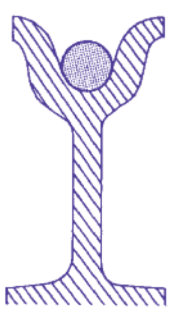
Sheave measured with ‘No-Go’ gauge having only 1/2 the rope oversize tolerance. New rope having full 5% oversize tolerance may not fit. Sheave must be replaced.



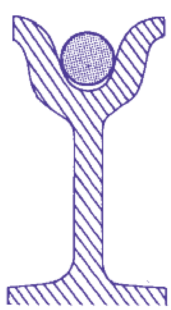
Same sheave measured with gauge having the full oversize tolerance of the rope. New rope would get pinched and develops damages like ‘Bird-Cages’ or ‘High-Stranding’.

Correctly + 5% sized plastic and stainless steel sheave gauges available from Unirope.

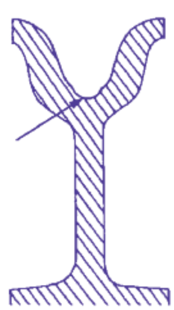




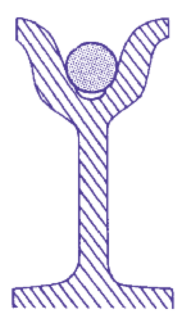
Properly matched rope & sheave groove



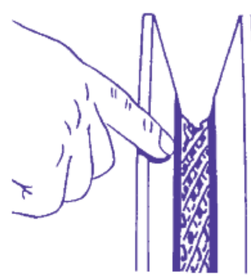
Sheave groove too small



Sheave groove is undercut

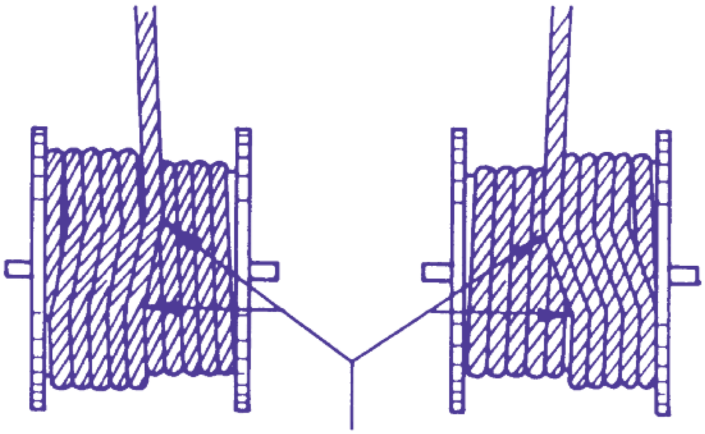


New rope will get damaged beyond repair.



A sheave corrugated by the rope’s ‘print’. This sheave will damage the rope.

Inspection of Wire Rope



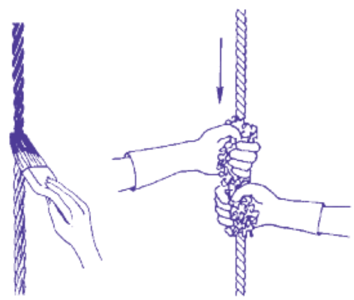
These are the cross-over points at which damage to a rope may occur first.

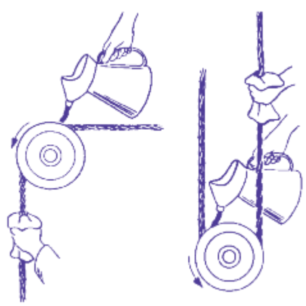
Cut and Slip Procedure

On multiple layer drums, wire rope will wear out at the crossover points from one wrap to the next. At these crossover points, the rope is subjected to severe abrasion and crushing as it is pushed over the rope 'grooves' and rides across the crown of the layer beneath. The scrubbing of the rope, as this is happening, can easily be heard.

In order to extend the rope's working life, shortening of the rope at the drum anchoring point of approx. 1/3 of the drum circumference, moves the crossover point to a different section of the rope. Now, a rope section previously not subjected to scrubbing and crushing will take the workload.

(See page -23- DRUMS)





Lubrication

During fabrication, ropes are lubricated; the kind and amount depending on the rope's size, type and use, if known. This in-process treatment will provide the finished rope with ample protection for a reasonable time if it is stored under proper conditions, and in the early stages of the rope's working life. It must be supplemented, however, at regular intervals.

Re-lubrication of a wire rope is not always a simple task. Apart from lubricant being a messy matter in itself, old lubricant, dirt and other particles may cover the outside of a rope to a point were any newly applied lubricant will not be allowed to penetrate the inside of a rope. In these cases it becomes necessary to either thoroughly clean the rope, or to use a high pressure lubrication device which forces new lubricant into the rope.

If the wire rope surface is clean, re-lubrication can also be made with spray cans of specially formulated lubricant which penetrates the inside of a rope.

The re-lubrication procedure and program is very much dependent on the length and size of a rope and on the equipment the rope is installed on. In any case, if a planned program of regular lubrication is not carried out, the rope will deteriorate more rapidly.

Remember that tests have shown that non-lubricated ropes will generate only about 1/3 of the bending cycles than ropes which are well lubricated. Python® ropes with a plastic coated core have the advantage that the inner rope is 'permanently lubricated'; the lubrication is 'sealed in'.

Original PYTHON® wire rope NYROSTEN lubrication is availabe in spray cans and 5 gal. pales. I has excellent penetration properties to lubricate the rope inside and out to maintain optimum rope fatigue properties.

Some Rope Data

Sheaves

We recommend only sheaves made of steel or cast steel. The following are recommended values:

Groove radius (r):
Minimum 0.53 to 0.535 x d
Maximum 0.55 x d
Recommended: ≈ 1% over the **actual** wire rope diameter.

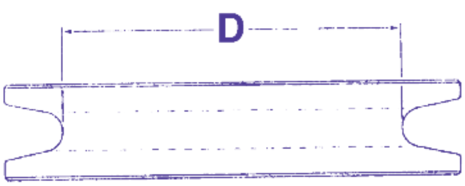
Groove depth (h):
Recommended: ≈ 1.5 x d or d x √2

Sheave throat angle:
For normal applications use 35˚ to 45˚ opening. Applications with deflection angles of more than 1.5˚ use 60˚ opening. Opening angles below 35˚ must be avoided.

Sheave hardness:
As the hardness of the single wires in a rope can be approximated to be 50-55 RC, the hardness on the sheave surface must be min. 35 RC, better is 40-45 RC.

D/d ratios:
Depending on the actual equipment and usage of wire rope in hoisting- or pulling applications the following D/d ratios are suggested:

CONSTRUCTION	Suggested Minimum D/d ratio
6 x 19 S IWRC	34
6 x 26 WS IWRC	30
6 x 25 FW IWRC	26
6 x 36 WS IWRC	23
Python® Multi	20
Python® Super 8	20
Python® Power 9	26
Python® Ultra	26
8 x 36	18
19 x 7 / 18 x 7	34
19 x 19	20
Python® Compac 18	20
Python® Lift	20
Python® Hoist	20
Python® Compac 35	20



Drums

Generally, we recommend grooved drums only. The rope is spooled properly and positively. Depending on the drum/rope diameter relationship helix-grooved drums can be used for up to 3 layers without excessive rope wear. For applications with more than 3 layers (e.g. Mobile cranes) we recommend 'Lebus' grooving.

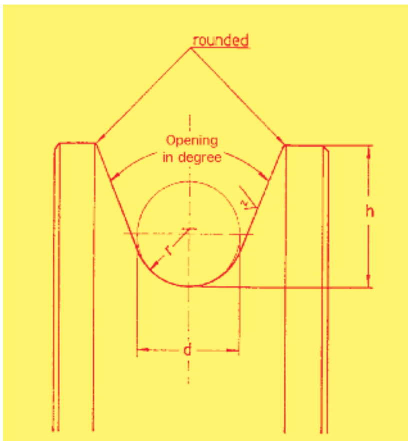
It has to be remembered, however, that rope service life on multiple layer drum systems will always only be a fraction of that compared with single layer helix-grooved drums.

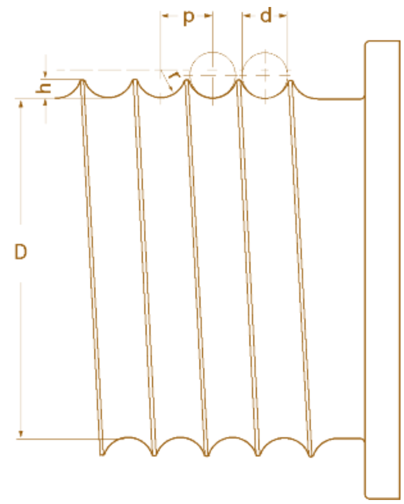
Important: For standard applications the drum grooving should be left hand to accommodate standard right hand lay ropes!

Groove radius (r):
Minimum 0.53 to 0.535 x d
Maximum 0.55 x d

Pitch diameter (p):
The pitch dia. has to be chosen in accordance with the groove radius. Under no circumstance should the pitch dia. be smaller than:
Minimum 2.065 x groove radius
Maximum 2.18 x groove radius
If these values are applied to **single layer grooved drums** the maximum permissible rope-deflection angle for regular wire rope constructions is 4˚. For non rotating /rotation-resistant ropes, and for Python Ultra and HS-9 the maximum permissible deflection angle is 1.5˚ only.

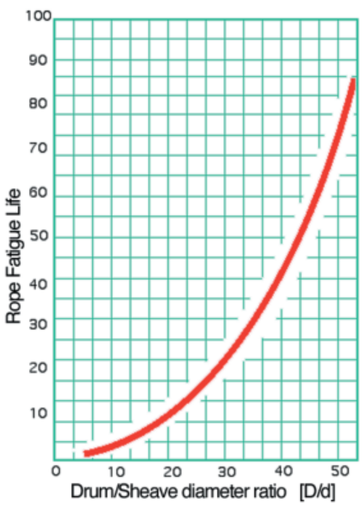
Groove depth (h):
Minimum ≥ 0.374 x d for helically grooved drums.

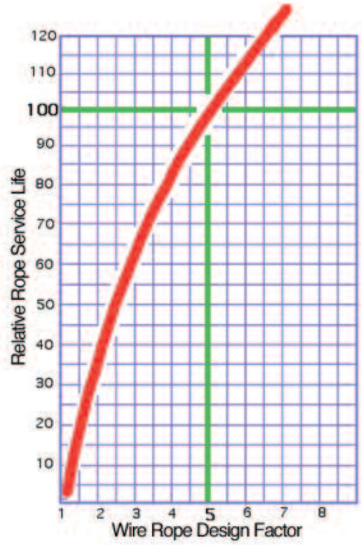




UNIROPE SLINGMAX

Some Rope Data





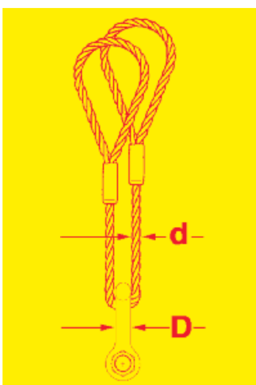
Relative Service Life

The ability of wire rope to withstand repeated bending work over sheaves and onto drums is also called the 'fatigue resistance'. This terms does NOT describe the ability to withstand mechanical damages nor the crush resistance of the rope.

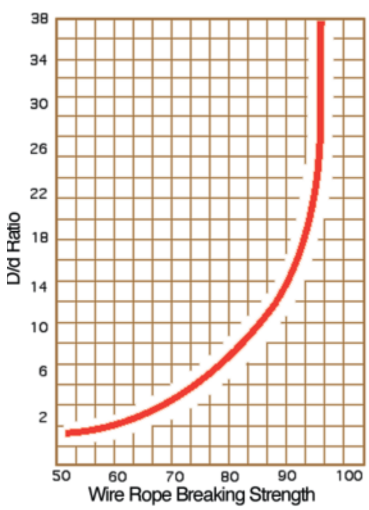
The fatigue resistance of a rope is not time but cycle dependent. Bending fatigue is the ability to withstand repeated bending over sheaves and drums and such ability is depending on factors such as drum diameter, groove dimensions, rope tension, line speed, rope construction, fluctuation between highest and lowest loads etc.

The tables show relative expected rope service life in relationship to D/d ratios and Design Factors.

For further information on this topic, please contact us for technical assistance and advice.



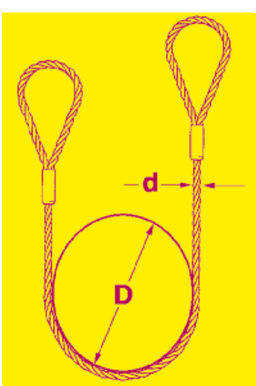
If the shackle or object has 2 times the diameter of a 6-strand wire rope sling (D/d 2:1) the basket sling capacity must be reduced by 40%



Loss of Strength over Sheaves or Pins

Rope breaking strength is determined in a standard test wherein fittings are attached to the ends of the rope and the rope is pulled in a straight line. If however, the rope passes over a curved surface (such as a sheave or pin) its strength is decreased. The amount of such reduction will depend on the severity of the bend as expressed by the D/d ratio. For example, a rope bent around a pin of its own diameter will have only 50% of the strength attributed to it in the standard test. This is called '50% efficiency'. Even at D/d ratios of 40, there may be a loss of up to 5%. At smaller D/d ratios, the loss in strength increases quite rapidly. The angle of bend needs not to be 180˚, 90˚, or even 45˚; relatively small bends can cause considerable loss.

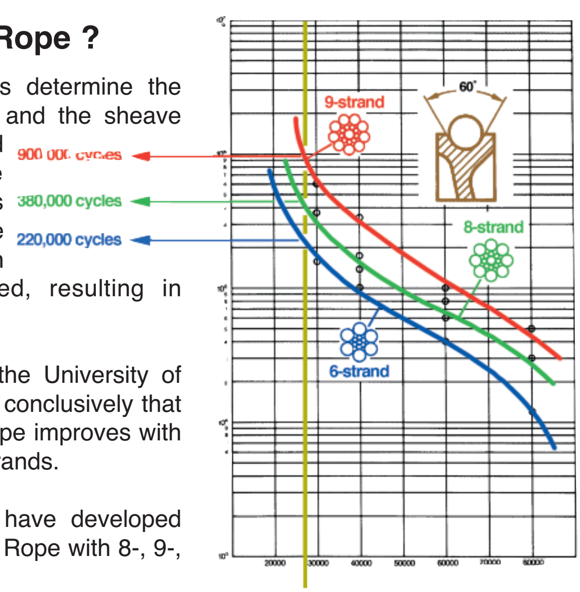
The table shown derived from standard test data as published by the 'Wire Rope Technical Board', is based on static loads only, and is a weighted average of 458 tests over pins and thimbles on 6x19 and 6x37 class ropes.



If the object lifted with a 6-strand wire rope sling in a basket hitch is at least 25 x larger than the sling diameter (D/d 25:1) the basket hitch capacity need not to be adjusted.

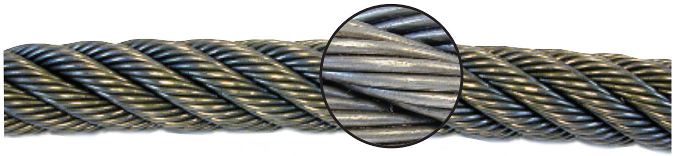
Why multi-strand Wire Rope ?

The number of outer strands determine the contact area between the rope and the sheave groove. If this area is increased the points of contact are multiplied and contact pressures are reduced. At the same time lateral notching stresses between strands and wires are reduced, resulting in increased fatigue life.

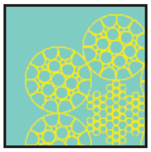
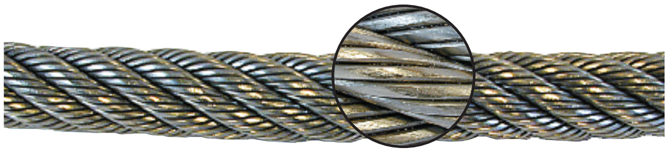


Extensive tests programs at the University of Stuttgart, Germany, have proven conclusively that the bending fatigue life of wire rope improves with an increasing number of outer strands.

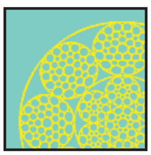
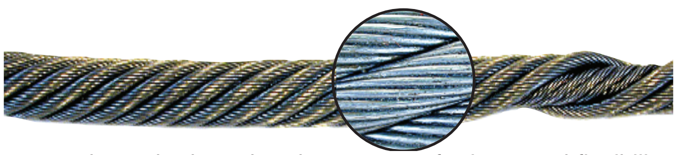
Based on that research we have developed Python® High Performance Wire Rope with 8-, 9-, and 10 outer strands.

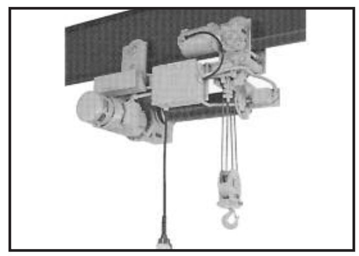
6-strand constructions, class 6x19 or 6x37 with fiber or steel core (IWRC) for general purpose crane and construction use.

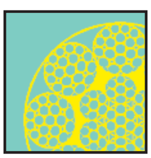
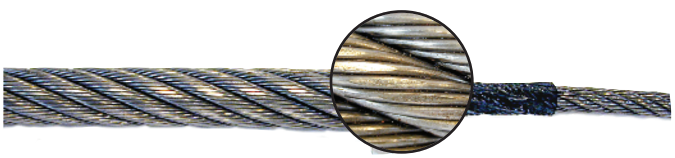



6-strand Compac® die-drawn wire rope to increase abrasion and crush resistance. Standard boom hoist rope for lattice cranes.

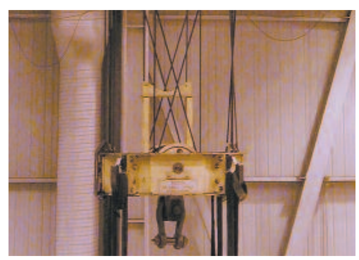



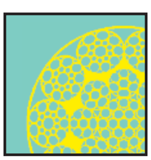
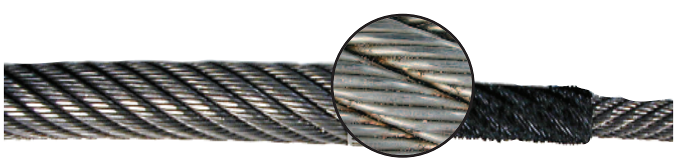
8-strand standard overhead crane rope for improved flexibility. Some sizes Available in DoPar construction.



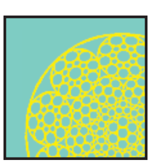
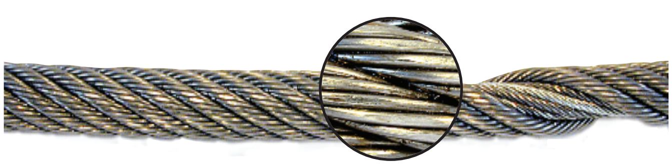



Python® Super 8 with plastic coated core to eliminate undetected core failures. Standard High Fatigue Resistant rope. Available in left and right lay

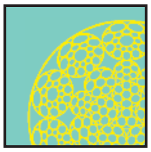
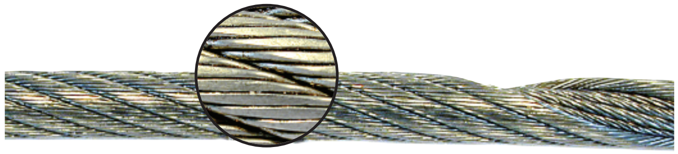


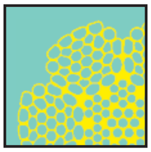
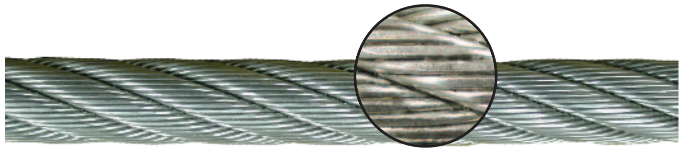
Python® Multi, spin resistant to avoid block twisting on overhead cranes. Plastic coated core to prevent core failures. Ultimate life time- and fatigue resistant properties.

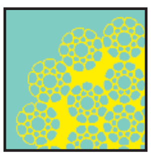
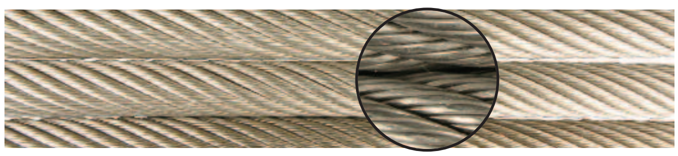
Python® Power 9, 9-strand DoPar construction to avoid strand nicking. Extra high strength fatigue resistant type for overhead cranes.

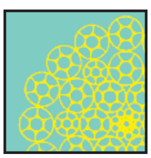
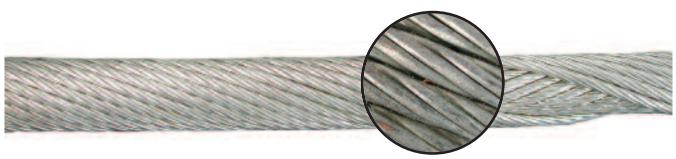
Python® Ultra, 10-strand DoPar made super high strength rope for engineered applications.

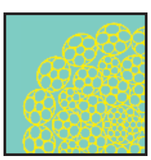
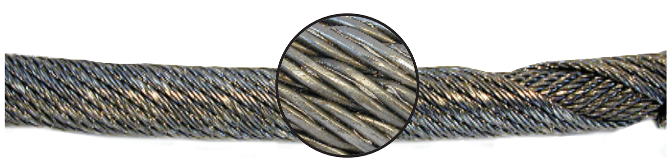
Python® Compac 6, very crush- yet high fatigue resistant boom hoist rope for multiple layer drum windings

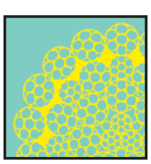
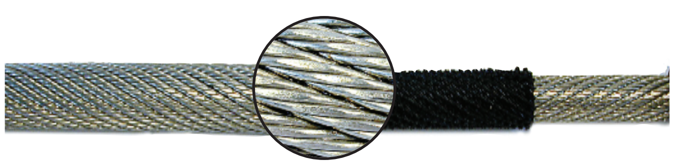
Python® Compac 18, rotation resistant compacted hoisting rope, extremely smooth surface for best performance on multiple winding drums, 19 wire strands, for mobile and truck cranes,

Python® Compac 35 non-rotating type for larger mobile cranes. Die-drawn strands for better abrasion and crush resistance.

Python® Lift, ultra high strength non-rotating rope for large lattice boom and tower cranes.

Python® Hoist non-rotating with plastic coated core to extend fatigue life due to shielding of core and strands. Plastic locks in factory applied lubricant.

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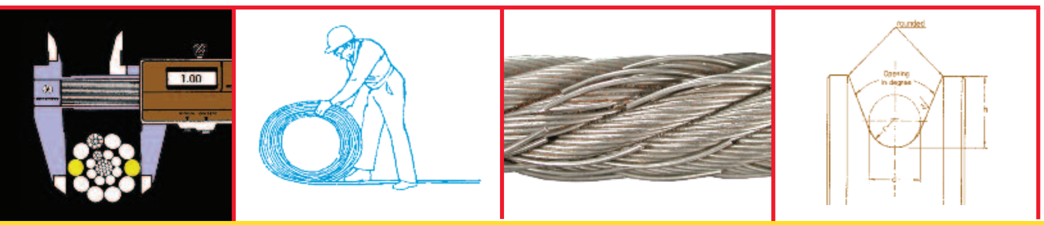
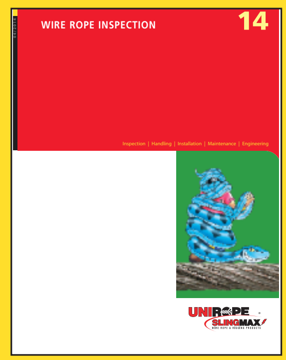
WIRE ROPE & RIGGING PRODUCTS



This instruction manual explains in detail some of the 'finer' points of wire rope installation, maintenance, and handling procedures and is written with the more experienced professional rope user in mind. In particular, this manual covers procedures which apply to high performance (Python®) and die-drawn (Compac®) wire rope.

Wire rope inspection never was, and never will be, a 'black or white' science. There are too many variations in the applications and in the equipment using wire rope. Although this publication makes an honest attempt to be complete, in the final analysis there is no one publication which can possibly cover all scenarios and thinkable circumstances leading to wire rope discard or damage.

WIRE ROPE INSPECTION



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