General Information

WIRE ROPE

A. Noble & Son Ltd. has been stocking and distributing wire rope almost since the inception of the company in 1911.

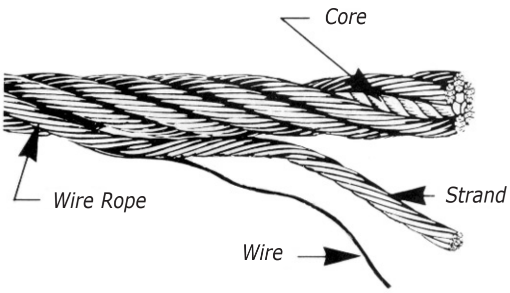
Apart from the distribution of wire rope Nobles personnel can supply guidance on correct usage and selection of wire rope. Nobles branches throughout Australia have swaging presses for terminating wire rope and NATA accredited tensile testing laboratories. The testing laboratories can be used for destruction testing and proof loading of wire ropes and wire rope assemblies.

A. Noble & Son Ltd. represents a range of wire rope manufacturers from all over the world who each have their own specialities in mine winding, crane and general purpose ropes.

Description, Size & Construction

A wire rope is made up of the basic components illustrated. The terms used to describe these component parts should be strictly adhered to, particularly when reporting on the conditions of ropes.

Describing wires as strands and strands as wire can be grossly misleading. For example, a report that a rope has a broken strand in most applications calls for immediate discarding of the rope, and subsequent cessation of operation, while a report that a rope has a broken wire in it should call for early inspection but seldom for discarding the rope.



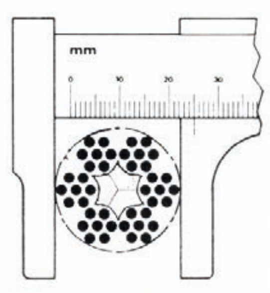
Composition of Wire Rope

Wire Rope Description

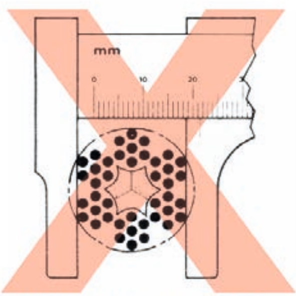
The properties of a wire rope are derived from its size, construction, quality, lay and type of core.

Size

Ropes are referred to by a diameter size. The correct way to measure wire rope is shown below.



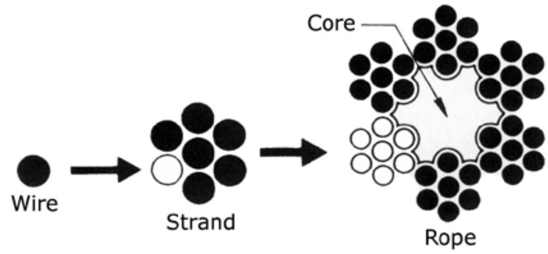
Correct Method



Incorrect Method

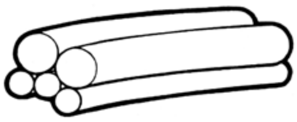
Construction

The main components of a wire rope are shown below.



In the above example, each individual wire is arranged around a central wire to form a 7-wire strand. Six of these strands are formed around a central core to make a wire rope. The rope is specified as 6x7 (6/1) – i.e. six strands each of seven wires.

The size and number of wires in each strand, as well as the size and number of strands in the rope greatly affect the characteristics of the rope. In general, a large number of small-size wires and strands produce a flexible rope with good resistance to bending fatigue. The rope construction is also important for tensile loading (static, live or shock), abrasive wear, crushing, corrosion and rotation.

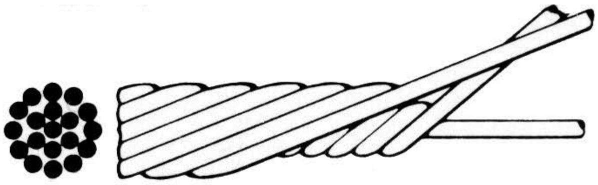


Equal Laid Rope

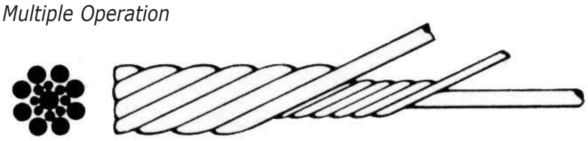
Cross Laid Rope

General Information

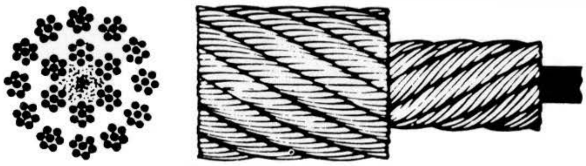
WIRE ROPE



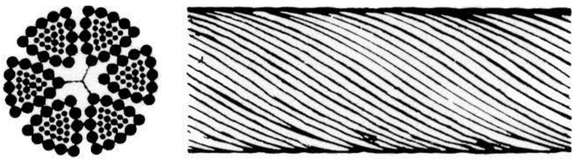
Multiple Operation



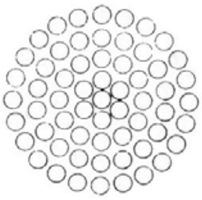
Single Operation



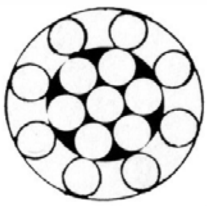
Rotation Resistant



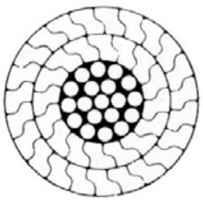
Triangular Strand



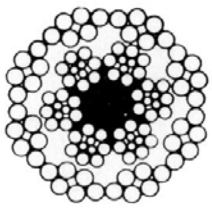
Galvanised Strand



Half Locked Coil



Full Locked Coil



Non-Rotating Mining

Multiple Operation: Individual strands are composed of successive layers of wire laid up at different lay lengths. This results in a cross laid rope.

This type of construction is now confined to a limited range of products such as ropes below 8mm diameter, and large sling and static ropes.

Single Operation: All wires in the strand are laid up in the one manufacturing operation. This type of rope is standard production, providing an equal laid rope that eliminates internal cross-mating and forms a compact strand of high metallic content. There are three main types: 6x9/9/1, 6x25 FW and 6x36 SW.

Rotation Resistant: The conventional rotation resistant wire rope is composed of a number of strands that are laid up in opposite directions to produce a non-rotating effect.

The 4 strand Mono Track is a complete departure from this convention and is created through theoretical analyses of the working torques.

Triangular Strand: The wires are specially formed to produce a strand with a triangular section – this type of rope is only produced in Lang's lay. This construction has improved wear and crush resistance and has wide application in winding and haulage systems.

Galvanised Strand: These are single strands of concentric layers of wires, some of which are cross laid to produce a non-rotating result.

Half Locked Coil: A strand with the outer layer composed of alternate shaped and round wires covering one or two layers of round wires laid in the opposite direction.

Full Locked Coil: A strand used as a rope and composed of one or two layers of Z-shaped wires laid over layers of half lock coil and/or layers of round wires.

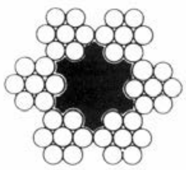
Rotation Resistant Mining Ropes: A rope composed of flattened strands of six or eight wires contra laid over a triangular strand rope to produce a rotation resistant result.

Cores & Wire Tensile

A number of core types are available and each gives specific properties to the rope:

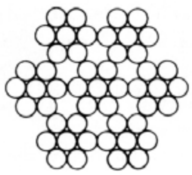
1. Fibre Core (FC) – sisal or polypropylene.
2. Wire Strand Core (WSC) – strand usually of the same construction as the outer strands.
3. Independent Wire Rope Core (IWRC) – a wire rope usually of 6x7 (6/1)/1x7(6/1) construction.

Fibre Core (FC) in 6x7 rope



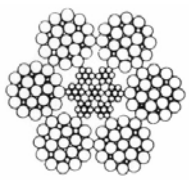
A fibre core, generally sisal, provides a resilient foundation for the strands in the rope structure. Fibre cores are used for ropes that are not subjected to heavy loading and where flexibility in handling is required. Fibre cores are inadequate where wire rope is subjected to heavy loading, prolonged to outdoor exposure and crushing on small drums and sheaves.

Wire Strand Core (WSC) in 6x7 Rope



These cores are used chiefly for standing ropes (guys or rigging), and offer higher tensile strength and, owing to the larger wires in the core, greater resistance to corrosion failure.

Independent Wire Rope Core (IWRC) in 6x25 FW Rope



In many instances it is recommended to use a wire rope with an independent wire rope core (I.W.R.C). Such a core is usually made up of 6 strands of 7 wires each plus centre strand.

The independent wire rope core provides:

1. Permanent support and uniform spacing of the strands laid around it; it is not compressible and has greater wear resistance than fibre core.
2. Permanent elastic stretch of the wire rope over a longer period of time.
3. Increased resistance to deterioration and deformation.
4. Delay of internal corrosion; the lubricant is not squeezed out of the core.
5. It increases the actual breaking load of the rope by at least 8% in the case of 6-strand ropes and about 25% in the case of 8-strand ropes.
6. Better performance for operating in very high temperatures.

An independent wire rope core increases the weight of a 6-strand rope by about 10%, and that of an 8-strand rope by approx. 20%.

Although a new rope with I.W.R.C. may be somewhat less flexible than a new rope with fibre core, it retains its relative flexibility whereas a rope with fibre core gradually loses its flexibility during use. Having better resistance to deterioration and deformation, a rope with I.W.R.C. is less susceptible to damage when used on small sheaves and drums than a rope with fibre core, it will also last longer before deterioration and deformation set in when wound on a drum in multiple layers.

Tensile Strength Grades

Wire ropes are usually supplied in the following tensile ranges:

Rope Grade	Range of wire tensile strength grades N/mm2
1570	1370 to 1770
1770	1570 to 1960
1960	1770 to 2160
2160	1960 to 2160

Rope Grade Equivalents

Rope Grade Designation	Equivalent Rope Grade
IPS	1770
EIPS	1960
EEIPS	2160

With the increasing use of heavy-duty and more compact equipment (e.g. power winches on mobile cranes and mine winding) there is a gradual upward trend in the required rope wire tensile range. However, as factors other than strength influence the life of wire rope, the specific application must be kept in mind when tensile strength of wire is selected.

Surface Finish

The most common are:

Galvanised wire rope - Zinc coated Class B is denoted with B (formerly G).

Galvanised wire rope - Zinc coated Class A is denoted with A (formerly G Class A).

Uncoated or Bright wire rope (Black) - is denoted with U (formerly B).

Preforming, Postforming & Lay

Preforming

A preformed rope is one in which the component strands are shaped to their final helical form before being laid into the rope.

Preforming can be applied to both Ordinary lay and Lang's lay ropes and, unless specifically ordered otherwise, all standard ropes are supplied preformed.

The advantages of preforming are mainly:

1. Reduction of internal stresses in the rope. This makes the rope easier to handle, install, reduces its tendency to kink and gives better spooling onto drums.
2. Greatly improved resistance to bending fatigue particularly in operation over small drums and sheaves.
3. Greater stability and better resistance to shock loading and abrasion.
4. Improved rope life due to the better equalisation of loading between strands in the rope and reduction of internal stresses in the rope.
5. Greater safety in handling of ropes as broken wire ends do not protrude. This factor also reduces wear on equipment in contact with the rope.

Postforming

Postforming is a manufacturing process applied to ropes to minimise stretch in service. It reduces the stretch caused by "bedding-in" the wires and strands onto their respective cores. In addition to controlling stretch, postforming produces results closely related to those achieved by preforming.

Postforming is particularly useful in overcoming stretch in long lengths of rope and where take-up adjustment is restricted. It is commonly applied to ropes used in aerial ropeways, guying, chairlifts and control cables.

Lay

This refers to the way the wires in the strands, and the strands in the rope are formed into the completed rope. The wire strands are essentially laid up in a planetary motion with controlled twist being imparted to produce a tightly formed rope.

The term "lay" is used in three ways:

1. To describe the direction in which the strands are laid in the rope, right or left. In a Right Hand lay strands are laid around the rope core in a clockwise direction – see illustration. In a Left Hand lay, the strands are laid anti-clockwise – see illustration. Steel Wire Ropes are conventionally produced Right Hand lay unless special circumstances require Left Hand lay.
2. To describe the direction in which the wires are stranded in relation to the direction of the strands in the completed rope, e.g. Ordinary lay or Lang's lay.

   Ordinary lay means the wires in a strand are laid in a direction opposite to the direction in which the strands are laid in the final rope.

   Lang's lay is the reverse of Ordinary lay. That is, the wires are laid in the same direction as the strands in the rope.

   Lang's lay ropes have superior properties in resistance to wear, abrasion, fatigue and scuffing. This is illustrated on the following page, where it can be seen that wear on an outer wire is distributed over a far greater area than in Ordinary lay.
3. "Lay" is also a measure of the pitch of a strand in a rope.

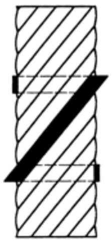
General Information

WIRE ROPE

Lay Directions & Types

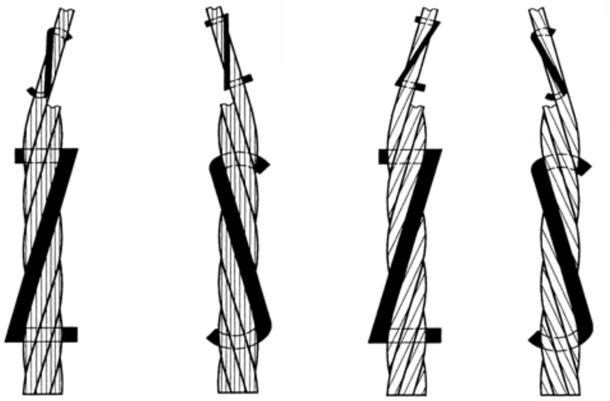
Lay direction of strands for stranded ropes are right (z) or left (s) and correspond to the direction of lay of the outer wires in relation to the longitudinal axis of the strand.

Lay direction of ropes are right (Z) or left (S) and correspond to the direction of lay of the outer wires in a spiral rope, the outer strands in a stranded rope or the unit ropes in a cable-laid rope in relation to the longitudinal axis of the rope.



z (right lay)

s (left lay)

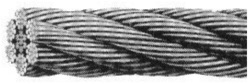


Ordinary lay *Lang's lay*

RHOL/RHRL (sZ) *LHOL/LHRL (zS)* *RHLL (zZ)* *LHLL (sS)*

Note: *The first letter of the symbol denotes strand direction and the second letter denotes rope direction.*

Right hand ordinary lay (sZ)

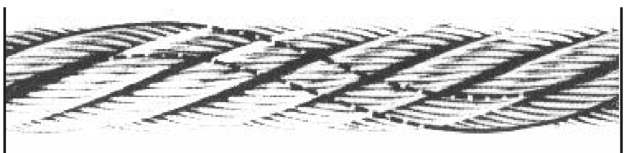


Right hand lang's lay (zZ)

Left hand ordinary lay (zS)

Left hand lang's lay (sS)

Right hand alternate lay (aZ)



One rope lay

Characteristics of Lay: The direction of rope lay does not affect the Breaking Force of a rope. However, the combination of strand lay and rope lay will greatly affect the rope characteristics and this factor must be taken into consideration when choosing a rope. Although the lay length can slightly affect rope behaviour the dominant aspect that influences performance is the direction of lay and whether it is Lang's lay or Ordinary lay. For example, the importance of rope lay is evident in a four-part highlift grab where rotation of the grab is prevented by the use of alternate right-hand and left-hand ropes.

Lubrication, Specifications, Testing & Plastic Coating

Lubrication

When a rope is operated over a drum or sheave, the strands and wires move relative to one another. To reduce the resultant friction within the rope as well as the friction between the rope and drum or sheave, ropes are lubricated in manufacture.
In addition this lubrication also retards corrosion and inhibits possible rotting of the fibre core. In special applications a combination of lubricants may be called for, e.g., the core and inner wires of the strands may be heavily lubricated while the lighter lubrication may be applied to outer wires and strands.

Wire rope cores are normally heavily lubricated irrespective of the outer strand lubrication.

Specifications

All standard ropes are produced to generally comply with the requirements of Australian Standards. However some of our more technically advanced wire ropes have special characteristics required to provide superior performance.

Testing & Inspection of Wire Ropes

Nobles can offer special services for rope users to assist in their inspection of used ropes. Our personnel have in many cases had a lifetime in the industry during which considerable experience has been gained.

The NATA accredited tensile laboratories in the various Nobles branches throughout Australia can provide tensile destruction testing services, while the company is also accredited by NATA to carry out non-destructive testing on wire ropes in situ.

Plastic Coated Wire Ropes

Plastic coatings are extruded onto a range of rope and stranded products for applications requiring a high resistance to corrosion. Plastic coated ropes are available in the following rope size and construction range:

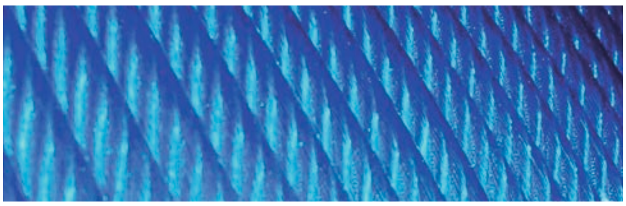
6x7 and 7x7 up to 8mm galvanised

6x19 and 7x19 up to 12mm galvanised

6x24 up to 12mm galvanised

Typical applications are rigging lines, handrails, steering lines and holding lines in the shipping, pearling and fishing industries.

Plastic coated strands are also available in PVC and black polyethylene.



Standard Blue PVC Coating on 6 x 19 FC B 1570 Wire Rope

General Information

WIRE ROPE

Ordering

The size, grade and construction of a rope must match the specific application and design factors.

Rope Length

Wire rope is manufactured to length tolerances as follows;

Up to 400m = +5% - 0%
400 to 1000m = +20m
Over 1000m = +2% - 0%

When a closer length is required, this should be specified in the order. In calculating rope length requirements, it is advisable to consider the following practical points for economy in operation:

1. In most cases, mining regulations require a test length be cut at specified periods. Sufficient extra length to cater for such tests over the expected service life of the rope should be added to the necessary operating rope length, plus a minimum of 2 1/2 drum turns for anchorage.
2. It is also advisable to make allowance for "cropping" in service as a consequence of wear or accidental damage at the capel end.
3. In many rope applications, wear and other deterioration are concentrated in spots along the length of the rope. It is often possible to gain economies in the overall life of the rope by providing additional length to enable feeding through of the new rope from the drum to spread the area of wear. This practice is regularly used to advantage on cable-operated earthmoving equipment and oil-well drilling rigs.
4. Short lengths of special rope constructions, if ordered in single units, can be costly to produce. Consideration of the number of such ropes in use and their probable service life can often make it more economical to order several such ropes at one time. As a rule, this helps to expedite production and lessens the possibility of delays in supply.

On existing equipment the rope size is generally fixed by the grooving of the sheaves and drums. Larger ropes should never be used without modification of drum and sheave grooving to suit the new rope. It should be remembered that ropes 8mm and above are made to a diameter tolerance of minus 0% to plus 5% with the exception of 6x24 construction, which has a tolerance of plus 7%.

Construction

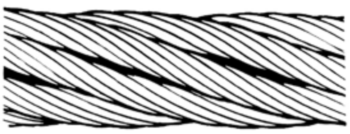
The construction of a rope for any given application should be suited to the equipment and to the conditions under which it will operate. It is important to nominate the construction when ordering. For example, the rope illustrated is ordered as 6x25 Filler Wire.

Rope Grade

The minimum tensile strength of the wire is expressed in megapascals.

Lay of Rope

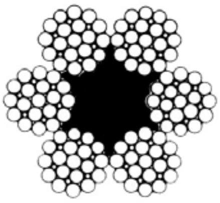
Lay affects behaviour and operating life of a wire rope. It is important therefore to quote (a) the direction of lay, and (b) the type of lay and details of the rope application and operating conditions. The illustration shows a right hand lang's lay (zZ) or RHLL rope. Ropes are normally supplied right-hand lay.



Right Hand Lang's Lay

Rope Core

The type of rope core must be specified because of the significant differences in properties of a wire rope core and fibre core.



6 x 25 FW Fibre Core

Ordering for Special Applications

To obtain the best rope recommended for particular equipment and operating conditions, information should be supplied on loading, sheave and drum diameters, speed of operation, corrosive conditions and fleet angles etc. A simple sketch of the rope rigging is a convenient means of showing this type of information.

All orders should contain information on the above factors.

When purchasers are not sure of the exact requirements the following particulars should be submitted:-

(a) Length and size.
(b) Load exclusive of mass of the rope.
(c) Dimensions of drums and sheave.
(d) Corrosive conditions.
(e) Sketch of the application.

Special aspects of rope supply may be necessary

The following check list is suggested:-

(a) Special length considerations such as minimum length, exact length.
(b) Special diameter tolerance.
(c) Rope end preparation.
(d) End attachments to inside or outside end.
(e) Stretch considerations.
(f) Special lubricant type and amount.
(g) Special reel dimensions, strength, shaft sizes, anchorage details and lagging.
(h) Despatch instructions.

EXAMPLE

A typical order for wire rope would read:

"500m 16mm 6x9/9/1 A, B or U 1770 Grade RHLL (zZ) IWRC."

Abbreviations, Prestretching & Seizing

Abbreviations

The following abbreviations have been standardised for ordering and identification purposes.

Wire Qualities

1570 MPa

1770 MPa

1960 MPa

I.P.S. – Improved Plough Steel

E.I.P.S. – Extra Improved Plough Steel

Constructions & Lays

RHOL	Right Hand Ordinary Lay (sZ)
LHOL	Left Hand Ordinary Lay (zS)
RHLL	Right Hand Lang's Lay (zZ)
LHLL	Left Hand Lang's Lay (sS)
RHAL	Right Hand Alternate Lay (aZ)
Pref	Preformed
Post	Postformed
IWRC	Independent Wire Rope Core
WSC	Wire Strand Core
FC	Fibre Core
FW	Filler Wire Strand Construction
TS	Triangular Strand Construction
W	Warrington Strand Construction
S	Seale Strand Construction
SW	Seale Warrington Construction
SF	Seale Filler Construction
D or d	Diameter (in millimetres)
FS	Flattened Strand
HLC	Half Locked Coil
FLC	Full Locked Coil

Prestretching

Is the loading of a rope or strand from 33.3% to 50% of its breaking load to remove constructional stretch, and this allows for the more accurate setting of lengths for guying and suspension cables.

The initial stretch cannot be accurately determined by theoretical means and will continue to take place until it has been completely removed.

After this initial stretch (or constructional stretch) has been removed the strand will have a truly elastic measure where elongation is proportional to applied load.

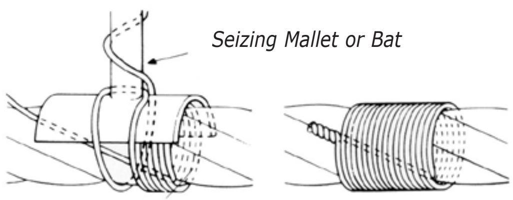
Seizing

Either of the following methods of seizing will ensure that the rope will later perform its job satisfactorily.

Long Seizing (for ropes over 26mm diameter)

1. Place one end of seizing wire in the valley between strands.
2. Take the long end of the wire and turn at right angles to itself and wind back over itself and the rope in a close tight seizing of the required length.
3. The amount of seizing should not be less than 6 to 8 times the rope diameter.
4. Twist the two ends of the wire together. Alternate tightening and twisting of the ends will draw the seizing up tight.
5. Cut the end of the twisted wires and knock down into a valley between two strands.

Long Seizing

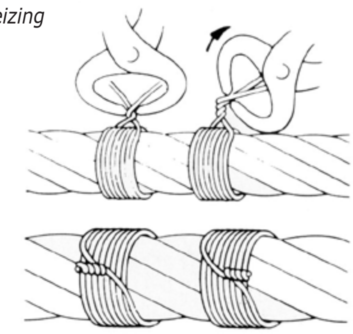


The above method is best applied using a seizing mallet or bat.

Short Seizing (for ropes below 26mm diameter)

1. Wrap the seizing wire around the rope eight or ten turns.
2. Twist the two ends of the seizing wire together approximately at the centre position of the seizing. Alternate tightening and twisting of the ends will draw the seizing up tight.
3. Cut the end of the twisted wires and knock down into a valley between strands.

Short Seizing



The number of seizings required depends on the type and diameter of the rope. The following minimum number of seizings are recommended:-

Preformed or Postformed ordinary lay – 1 seizing.

Lang's lay rope with wire rope core and rotation resistant ropes – 2 seizings.

Seizing Wire

Both soft annealed single wire and stranded seizing wires are used in the seizing of steel wire ropes. Suitable sizes are listed below:-

List of Seizings Recommended For Standard Ropes

Rope Diameter (mm)	7 wire seizing strand	Single seizing wire
Up to 14		0.90
16 – 26		1.25
28 – 38	7/0.90	2.00
Over 38	7/1.25	2.75

Transport, Storage & Handling

Transporting

Ropes are supplied on reels or in coil form. When transporting, care must be taken not to damage rope by contact with other goods. Reels and coils should be lifted rather than dropped, tipped or rolled, to avoid damage.

Ropes should be uncovered as soon as they are received and checked for possible transit damage.

Storage

Ropes, whether on reel or in coils, should be stored on blocks off the floor to prevent sweating and corrosion and under cover in dry conditions free from possible attack by corrosive agents, such as milldust, sulphur or acid fumes.

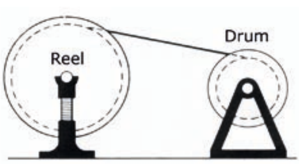
If ropes are to be stored for any length of time in warm or hot conditions likely to cause the lubricant to drain to the lower side of the reel, the reels should be mounted on a horizontal shaft and turned over periodically to maintain uniform lubrication of the rope. Additional lubrication may be necessary.

Removed ropes awaiting further use, should be thoroughly cleaned, inspected, lubricated and stored under the same conditions as new ropes.

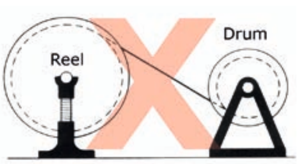
Handling

Incorrect handling of rope from reels and coils can result in springing of wires and strands and kinking of the rope. This type of damage can seldom be entirely corrected and can greatly reduce the effective life of the rope.

The drawings show correct and incorrect methods of reeling a rope from the transport reel onto a drum or another reel. The transport reel should be firmly mounted and braked to prevent overrunning and give tight rewinding. A suitable stand for the reel is also shown.



Correct method



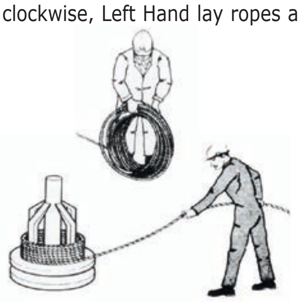
Incorrect method

Methods of removing rope from reels & coils

Turntables, preferably mounted on the floor, may be used for unwinding ropes from reels stored on their sides. Care must be taken to brake such turntables, as over-running could cause the rope to slacken, fall off and foul under the turntable.

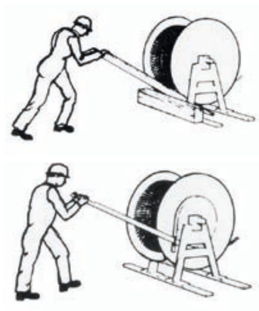
If a coil is too large to be handled manually it should be mounted on a turntable or suspended by a spindle from a swivel crane hook.

When coiling ropes down by hand on the floor, an occasional coil wound "underhand" relieves torque and provides a more easily handled coil. Right Hand lay ropes should be coiled down clockwise, Left Hand lay ropes anti-clockwise.



***Incorrect method:** Don't pull the rope from a stationary coil.*

***Correct methods of taking ropes from coils:** Roll the coil along the ground or use a turntable.*



***Correct methods of taking ropes from reels:** When a large reel is used, it is recommended that a plank is used as a brake against the reel flange or on the shaft or side plate.*

⚠ WARNING

- When releasing rope from coils or reels, care must be taken to retard the violent release of the rope end which could cause damage, serious injury or death.

Installation

Rope Equipment Checking

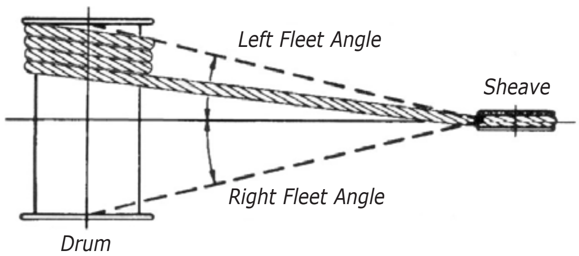
Improved rope performance can be obtained by paying attention to the following areas:

- Sheaves should be grooved to the nominal rope diameter plus an allowance of 7% to allow for rope manufacturing tolerances and should be re-machined when worn to nominal diameter plus 3%. Sheaves must also be free from score marks, run freely and be true.
- Guides and rollers must be free from undersized grooving and broken flanges, and should run free and true.
- Drum grooves should be checked for size and riser plates checked for effectiveness.
- Displaced or damaged cheek plates in rope blocks or safety guards should be repaired.
- Grabbing clutches and brakes should be repaired and adjusted to obviate impact loads on the rope.
- End fittings, such as wedges, sockets and drums anchorages, should be inspected for excessive wear.

The fleet angle has an important bearing on the winding of a rope from sheave to drum, particularly at high operation speeds. If winding is to take place smoothly, the fleet angles on both sides of the drum will have to be kept within acceptable limits.

Excessive fleet angles can result in considerable abrasive damage to both sheave flanges and rope and considerably reduce the life of the rope and the equipment.

Fleet angles normally range to a maximum of 1.5° for plain drums and to a maximum of 2.5° for grooved drums. Smaller angles are required for high speed haulage such as mine windings. Unless the head or guide sheave is centred with respect to the drum, there will be different values for the left and the right fleet angles.



Rope End Preparation

Normally wire ropes are delivered with seized ends. As a rule, no further preparation is necessary, but in some cases where ropes must be reeved through restricted openings, such as drum anchorages and blocks systems, the rope can be supplied with welded tapered ends or with links welded on the ends. The latter enables the new rope to be installed by attaching it either to the old rope or a tow rope and drawing onto the equipment.

Tensioning Rope

Wire rope for multi-layer drums must be installed under tension. It is imperative that the bottom layer is tight with the exact number of turns on the drum.

Wire Rope Life

The main factors, which affect rope life are:

1. Basic design of equipment or installation:

Sheave size, drum design and drum diameter can directly affect wire rope life. For example, doubling the sheave size can produce up to four times the rope life. The minimum ratios in the following table should be adhered to:-

Recommended Minimum Ratio of Drum & Sheave Diameter to Rope Diameter

Rope Construction	Ratio
6 x 7	43
6 x 19S (9/9.1)	32
6 x 21FW (10/5 + 5F/1)	30
6 x 19W (6 & 6/6/1)	30
6 x 25FW (12/6 + 6F/1)	23
6 x 36SW (14/7 & 7/7/1)	22
6 x 26WF (7 & 7/7/4/1)	22
6 x 24 (15/9/F)	22
6 x 29FW (14/7 + 7F/1)	22
6 x 41SW (16/8/8 & 8/8/1)	21
6 x 37 (18/12/6/1)	21
19 x 7	23
35 x 7	20
4 x 39 Mono Track	20

For Casar Ropes refer to A. Noble & Son Ltd.

2. Operating Environment:

Corrosion – when corrosive conditions exist, regular rope inspection, particularly of the IWRC, is essential. The effects of corrosion can be partly offset by the use of galvanised wire rope.

Temperature – excessively high operating temperatures can lead to deterioration of the wire rope core, and thereby cause rope fatigue.

3. Rope Maintenance:

End for ending and cropping – in certain applications, e.g., drag ropes, it is possible to "end for end" the rope. This will give longer rope life due to the wear points being re-located. If additional rope can be accommodated on the drum, then progressive cutting back (cropping) will bring "new" rope into the system, and will re-locate wear points.

Treatment of broken wires – broken wires affecting the life of adjacent wires should be removed.

Discard practices - clear policies regarding discard should be formulated. Rope Maintenance Schedules, based on experience, should be drawn up to provide periodic inspections and removal cycles for each rope as well as inspections of individual components such as the sheaves. Regular maintenance ensures optimum rope life, minimises down time of plant and equipment and increases the efficiency of the operation.

Broken Wires

General purpose ropes, crane ropes and hoist ropes should be discarded whenever any of the types of degradation exceed the limits given in the Table below. However, the rope life may be ended before these limits are reached.

The table below allows for internal wire breaks and is valid for all constructions of rope. In 6-strand and in 8-strand ropes, wire breaks occur principally at the external surface. This does not apply to wire ropes having a number of layers of strands (typically multistrand constructions), where the majority of wire breaks occur internally and are therefore non-visible fractures.

Limit of Degradation for Discard of General Purpose Lifting Ropes, Crane Ropes & Hoist Ropes *(see Notes 1 & 2)*

Type of degradation	Construction (see Note 3)	Limit of degradation for discard (see Note 4): Maximum allowable number of broken wires over a length of 6 times the rope's diameter	Limit of degradation for discard (see Note 4): Maximum allowable number of broken wires over a length of 30 times the rope's diameter
Broken wires	6 x 19 (12/6/1)	5	10
	6 x 19 S (9/9/1)	3	6
	6 x 26 SW (10/5 and 5/5/1)	5	10
	6 x 25 FW (12/6 and 6/1)	5	10
	6 x 29 FW (14/7/7/1)	7	14
	6 x 24 (15/9/F)	5	10
	8 x 19 S (9/9/1)	5	10
	8 x 25 FW (12/6 and 6/1)	6	13
	6 x 36 SW (14/7 and 7/7/1)	7	14
	6 x 37 (18/12/6/1)	10	19
	6 x 41 SW (16/8 and 8/8/1)	9	18
	18 x 7 NR	1	2
	34 x 7 NR	2	4
	4 x 48	2	4
Wear	All types	Outer wires are worn more than one third of their diameter	
Loss of area	All types	The loss of metallic area due to visible combined wire wear and broken or cracked wires exceeds 10%	
Corrosion	All types	Corrosion is marked by noticeable pitting or loosening of outer wires	

NOTES:

1. *The number of wire breaks before discard in the above table is quite high, and if wire breaks are concentrated in one strand, lower levels for discard are appropriate. If more than one third of the outer wires in a strand are broken over a length of six times the rope diameter, the rope shall be discarded.*
2. *Where ropes are used for lifts, AS 1735.2 applies, which is less stringent than the above table. The mining industry frequently requires more stringent discard criteria.*
3. *Rope of Lang's lay construction other than rotation resistant ropes shall have no more than 50% of the above values.*
4. *Number of broken wires alone is not the only factor in discarding a wire rope.*

For Casar and 4 x 39 Mono Track wire ropes refer to A. Noble & Son Ltd.

General Information

WIRE ROPE

Care & Maintenance

Breaking in

A wire rope may be looked upon as a machine composed of a large number of moving parts. As such it should be broken in as soon as it is installed, by loading it very lightly for a few cycles and then gradually stepping up the load, to enable both wires and strands to 'bed down' into the working positions, with the load distributed as uniformly as possible.

With strand 6 and 8 stranded ropes, the torque can greatly diminish after breaking in by releasing the connection and allowing the torque to run out. This procedure may have to be repeated until the constructional stretch has been worked out of the rope and it has become neutral.

The use of 'spinners' or swivels should be avoided whenever possible. All ropes should be reeled onto winch drums as tightly and uniformly as possible during the initial installation.

Inspection

Wire rope is tough and durable, but nonetheless expendable and eventually reaches the end of its safe service life.
Rope deterioration becomes noticeable through the presence of broken wires, surface wear, corrosion, wire or strand distortion due to mechanical abuse, or drastic reduction in diameter and lengthening of the lay. Also deterioration can be detected by the use of non-destructive testing techniques. Wire ropes should periodically be inspected for signs of deterioration.

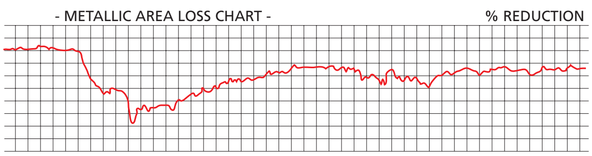
While Statutory Regulations govern the inspection and discarding of certain wire ropes, the same rules cannot be applied to all ropes. The proper frequency and degree of inspection depends largely on the possible risk to personnel and machinery in the event of rope failure. The determination of the point at which a rope should be discarded for reasons of safety requires judgment and experience in rope inspection in addition to knowledge of the performance of previous ropes used in the same application.

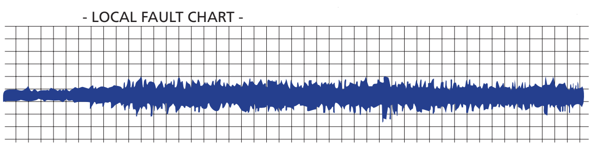
Where the Statutory Regulations are laid down for the inspection and discarding of wire ropes and their attachments, wire rope users should become fully acquainted with the regulations and see that they are carried out.

Sufficient records should be kept to provide a reliable history of the ropes under their control. Inspection of both operated and discarded ropes frequently indicates equipment faults that have a large bearing on the service life and safety of the rope. It is therefore essential to inspect the equipment on which the rope is used as well as the rope itself.

Non Destructive Testing

This method of inspection of wire ropes has become part of the mining industries standard requirements for over 20 years.
An electromagnetic instrument is used to non-destructively examine the rope. It incorporates a sensor head that is able to induce a magnetic field in a section of rope that is located within the instrument. Changes in the metallic field enable a chart to be produced showing changes in metallic cross-sectional area and any wire breaks or other anomalies. Life of costly wire ropes may be extended by this sophisticated method.





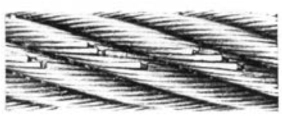
Deterioration

Typical examples of wire rope deterioration

1. *Mechanical damage due to rope movement over sharp edges whilst under load*

2. *Localised wear due to abrasion on supporting structure.*

3. *Narrow path of wire breaks caused by working in a grossly oversized groove or over small support rollers.*



4. *Severe wear in Lang's Lay, caused by abrasion at cross-over points on multi-layer coiling application.*

5. *Corrosion of severe degree caused by immersion of rope in water.*

6. *Typical wire fractures as a result of bend fatigue.*

7. *Wire fractures at the strand, or core interface, as distinct from 'crown' fractures caused by failure of core support.*

8. *Typical example of localised wear and deformation created at a previously kinked portion of rope.*

9. *Multi-strand rope 'bird caged' due to torsional unbalance. Typical of build-up seen at anchorage end of multi-fall crane application.*

10. *Protrusion of IWRC resulting from shock loading.*

Stretch in Ropes

When load is first applied to a new rope it stretches due to the individual wires settling down. This is referred to as the Initial or Manufacturing Stretch. Subsequently a gradual stretch takes place during the whole of the rope's life; the amount depends on many variables such as length, type of construction, loading and the modulus of elasticity of the particular rope.

$$T = (2W + Lw)\left(\frac{L}{2a\,E}\right)$$

Where T = Stretch in metres
W = Load in kgs
L = Length in metres
w = Weight of rope in kgs/metre
a = Cross sectional area of rope in millimetres^2
E = Modulus of Elasticity, kgs/mm^2

To forecast the amount of stretch accurately for a rope under a given set of conditions, calculations must be based on the result of a load/extension test on a sample from the particular rope. However, if the results of such a test are not available, an indication of the increase in length can be obtained from the formula.

Approximate Modulus of Elasticity for New Ropes

6 x 7 FC	96 GPa	(0.0098 x 10^6 kgs/mm^2)
7 X 7	117 GPa	(0.0119 x 10^6 kgs/mm^2)
6 X 19 FC	89 GPa	(0.0091 x 10^6 kgs/mm^2)
6 X 19 IWRC	110 GPa	(0.0112 x 10^6 kgs/mm^2)
7 Wire Strand	145 GPa	(0.0148 x 10^6 kgs/mm^2)
19 Wire Strand	125 GPa	(0.0127 x 10^6 kgs/mm^2)
36 Wire Strand	110 GPa	(0.0012 x 10^6 kgs/mm^2)
6 x 36 IWRC	82 GPa	(0.0084 x 10^6 kgs/mm^2)
6 x 36 FC	82 GPa	(0.0084 x 10^6 kgs/mm^2)
6 x 12/12/ Δ FC	96 GPa	(0.0098 x 10^6 kgs/mm^2)
Locked Coil Winding Rope	125 GPa	(0.0127 x 10^6 kgs/mm^2)
Locked Coil Guide Rope	138 GPa	(0.0141 x 10^6 kgs/mm^2)
For used ropes 20% should be added to these figures.		

Calculation of Cross Sectional Area of Wire Rope

A = F x d^2
A = Metallic area of rope with fibre core in mm^2
F = Compactness factor
d = Nominal diameter of rope in millimetres
For 6 strand rope with IWRC add 15%, with strand core add 20%
For flattened strand rope with IWRC, add 10%
For 8 strand rope with IWRC, add 20%

Compactness Factor F

Rope Construction	Factor F
6 x 7	0.38
6 x 19/6 x 21	0.395
6 x 25 Filler Wire/6 x 36 Group	0.405
7 Wire Galvanised Guy Strand	0.596
19 Wire Galvanised Guy Strand	0.580

Tolerances on rope diameter

Nominal Rope Diameter *d* mm	Tolerance as percentage of nominal diameter	
	Ropes with strands that are exclusively of wire or incorporate solid polymer centres	Ropes with strands that incorporate fibre centres*
2 ≤ *d* < 4	+8 -0	-
4 ≤ *d* < 6	+7 -0	+9 -0
6 ≤ *d* < 8	+6 -0	+8 -0
≥8	+5 -0	+7 -0

** For example 6 x 24FC*

Permissible differences between any two diameter measurements

Nominal Rope Diameter *d* mm	Tolerance as percentage of nominal diameter	
	Ropes with strands that are exclusively of wire or incorporate solid polymer centres	Ropes with strands that incorporate fibre centres*
2 ≤ *d* < 4	7	-
4 ≤ *d* < 6	6	8
6 ≤ *d* < 8	5	7
≥8	4	6

** For example 6 x 24FC*

General Information

WIRE ROPE

The following tables show rope mass in "kg per 100 metres" and breaking force in "kilonewtons" for the various rope groups.

It will be noted that the value varies from group to group since the various constructions contain different steel areas and variable losses are incurred as the result of the stranding of the wires.

Wire quality has been nominated in 1570, 1770 and 1960 grade for the majority of wire ropes, the value 1570, 1770 etc. corresponds to the minimum tensile strength of the wire expressed in megapascals. Marine and General Purpose galvanised ropes have been nominated in 1570 grade and are confined to certain rope constructions. Other 6 strand constructions in galvanised rope should be ordered in 1770 grade.

The breaking forces of rope of tensile grades other than 1770 can be calculated by multiplying the value of 1770 grade by the ratio of the grade number. The grade of 2070 is the preferred high tensile grade for 6 strand ropes but 1960 is preferred for 19x7, 35x7 and most Casar ropes.

All ropes are in millimeter diameter. Only preferred sizes have been included in the tables. Non preferred sizes should be the subject of special inquiry. Special non preferred sizes to suit existing deep mining and large excavator equipment are available although new equipment should use only preferred diameters.

The breaking force unit is the kilonewton, this being the force which, applied to a mass of one kilogram, produces an acceleration of one metre per second. The minimum rope breaking force required will depend on the factor of safety covered by the application and in the case of a single supporting rope where the rope mass is ignored will be equal to the gravitational force multiplied by the factor of safety. Minimum rope breaking force (kN) = Mass (tonnes) per rope part x factor of safety required x 9.81.

To calculate approximate mass equivalent, at sea level, divide kilonewtons by 9.81

Example: 12mm 6 x 7 Fibre Core G1570 grade

$$= 75 \text{ kN} = \frac{75}{9.81} = 7.65 \text{ tonnes}$$

For most practical purposes, divide by 10 in lieu of 9.81

TYPICAL ROPE RECOMENDATIONS

Applications		Size Range Dia. (mm)	Rope Recommendations	Lay Preformed	Core	Factors of Safety
LOGGING	Log Winch	13 - 28	19S	RHOL	IWRC	Logging Skylines.......................3.5
		32 - 36	25FW	RHOL	IWRC	
	Log Skidder	13 - 28	19S, 25FW	RHOL	IWRC	
	Yard Rope	16 - 20	25FW, 29FW	RHOL	FC	
PILING	Pile Driving Hammer	16 - 32	36	RHOL	IWRC	
	Drop Hammer	16 - 32	25FW, 36SW, 4x39	RHOL	FC	
	Pile Handling	13 - 24	25FW	RHOL	IWRC, FC	
SLINGS	Slings - Standard	9 - 32	24, 36SW	RHOL	FC, IWRC	AS 1666 - 1995......................5.0
	Slings - High Tensile	9 - 28	25FW, 36SW	RHOL	IWRC	
		32 - 104	36SW, 41SW	RHOL	IWRC	
CRANES	Tower - Hoist	20 - 42	Eurolift, 35x7, Powerlift, Starlift	RHOL or RHLL		For safety factors on cranes refer to AS 1418.1:2002
	Tower - Luffing	20 - 42	4x39, Stratoplast, Turboplast	RHLL		
	Trolley Line	13 - 24	25FW, 36SW	RHOL	IWRC	
	Overhead	6 - 10	19x7, Starlift			
	1 - 3 Falls	12 - 18	35x7, Eurolift, 4x39	RHOL		
	Overhead		Stratoplast, Turboplast	RHOL or RHLL	IWRC	
	4 Falls or more		25FW, 36SW, Betalift, Alphalift	RHOL or RHLL	IWRC	
	Mobile - Hoist	11 - 20	Eurolift, Starlift, 19x7, 35x7,4x39	RHOL or RHLL		
		22 - 32	Eurolift, Starlift, 19x7, 35x7,4x39	RHOL or RHLL		
	Mobile - Luffing	13 - 26	25W, Stratoplast, Turboplast	RHLL	IWRC	
GRABS	Grab - Holding	18 - 28	25FW, 36SW, 4x39	RHOL or RHLL	IWRC, FC	....5.0
	Closing	18 - 29	Stratoplast, Turboplast	LHOL or LHLL		
WATER DRILLING		14 - 18	24, 4x39	LHOL, RHOL	FC	
DRILLING	Diamond	12 - 16	19x7, 4x39	RHOL	FC	
		16 - 20	35x7, 4x39	RHOL*	FC	
SHIPPING	Mooring	16 - 26	24, 36SW	RHOL	FC	
		26 - 40	36SW, 41SW	RHOL	FC	
	Towing	32 - 56	36SW, 41SW	RHOL	FC, IWRC	
	Loading Gear - Lashing	12 - 32	24	RHOL	FC	
	Rigging	10 - 32	7x7, 7x19	RHOL	IWRC	
SLIPWAY		16 - 32	24, 36SW	RHOL	FC	
		32 - 56	36SW, 41SW	RHOL	FC, IWRC	
WINCHES	Trailer - Boat	5 - 8	19, 7x19	RHOL	IWRC, FC	
	General Purpose	8 - 28	19S, 25FW, 36SW	RHOL	IWRC	
		32 - 64	25FW, 36SW, 41SW	RHOL	IWRC	

***Note:** 6 Strand ropes except where otherwise stated.*