GENERAL PURPOSE CATALOG

Bethlehem Wire Rope®

Wirerope Works, Inc.

manufactured by
Wirerope Works, Inc.

Bethlehem Wire Rope
Wirerope Works, Inc.

Wirerope Works, Inc. (WW) manufactures Bethlehem Wire Rope® to meet the exacting demands of modern lifting practices. The key to the success of Bethlehem Wire Rope is the total commitment WW makes to the lifting industry.

Committed to the Consumer

We continue to support our customers by offering supply contracts and field evaluations of rope performance. We work with our customers to ensure maximum return of the investments made in equipment.

Committed to Quality

WW is certified to ISO 9001:2008 and API 9A by the American Petroleum Institute (API). We are also certified by the American Bureau of Shipping (ABS) and Lloyd's of London.

Committed to Service

We service the industry with a large warehouse network, while developing additional outlets for our products, e.g., distributors. In addition, we continue to train and educate consumers in the use and application of wire ropes.

QUALITY REGISTRAR
ISO 9001:2008
Wirerope Works, Inc. Williamsport Facility
REGISTRATION NO. 0049
WILLIAMSPORT, PA 17701

Owned by Americans.
Made by Americans.

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Wirerope Works, Inc. (WW) manufactures Bethlehem Wire Rope® products in a wide variety of constructions, cores and steel grades. This catalog contains general information on wire rope constructions emphasizing the most common applications, based upon new, unused wire rope. Abuse or failure to exercise proper care and maintenance can significantly alter a wire rope's characteristics, particularly the breaking strength.

The technical data contained herein is based on accepted engineering practices and, where applicable, is in accordance with Occupation Safety and Health Administration standards. In use, this data should be supplemented by the application of the professional judgement of qualified engineering personnel.

If your specific wire rope needs or requirements are not shown in this catalog, please consult WW's sales or engineering department for technical information and recommendations.

Wire rope products will break if abused, misused or overused. Consult industry recommendations and appropriate Standards before using. Wirerope Works, Inc. warrants all Bethlehem Wire Rope® and Strand products. However, any warranty, expressed or implied as to quality, performance or fitness for use of wire rope products is always premised on the condition that the published breaking strengths apply only to new, unused rope, that the mechanical equipment on which such products are used is properly designed and maintained, that such products are properly stored, handled, used and maintained, and properly inspected on a regular basis during the period of use. Wirerope Works, Inc. expressly prohibits the resale of worn, previously owned and used Bethlehem Wire Rope and Strand products. Immediately following removal from service, all wire rope products are to be properly disposed of in accordance with applicable municipal, state, and federal guidelines. Manufacturer shall not be liable for consequential or incidental damages or secondary charges including but not limited to personal injury, labor costs, and a loss of profits resulting from the use of worn, previously owned and used products. Manufacturer shall not be liable for consequential or incidental damages or secondary charges including but not limited to personal injury, labor costs, a loss of profits resulting from the use of said products or from said products being incorporated in or becoming a component of any product.

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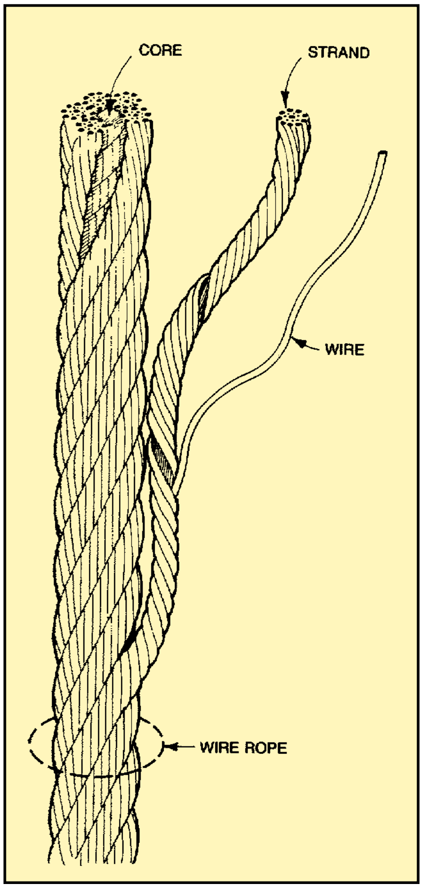
Wire rope is a machine composed of a number of precise, moving parts, designed and manufactured to bear a very definite relation to one another. In fact, some wire ropes contain more moving parts than many complicated mechanisms. For example, a 6-strand rope with 49-wire strands laid around an independent wire rope core contains a total of 343 individual wires. All of these wires must work together and move with respect to one another if the rope is to have the flexibility necessary for successful operation.

Wire rope is composed of wires, strands and a core. The basic unit of wire rope is wire, which is carefully processed and drawn from selected grades of steel to predetermined physical properties and sizes. A predetermined number of finished wires is then helically laid together in a uniform geometric pattern to form a strand. This process must be performed with precision and exactness to form a strand of correct size and characteristics. The required number of suitably fabricated strands are laid symmetrically with a definite length of lay around a core, forming the finished wire rope. All Bethlehem Wire Rope products are manufactured at WW's facility in Williamsport, Pennsylvania.

Three Components of Wire Rope



Wire Rope Construction

Wire rope is identified by its construction, or the number of strands per rope, and number of wires in each strand. For example, the construction 6x25 denotes a 6-strand rope, with each strand having 25 wires. Constructions having similar weights and breaking strengths are grouped into wire rope classifications, such as the 6x19 and 6x37 Classes.

Wire Rope Finish

The term ***bright*** refers to a wire rope manufactured with no protective coating or finish other than lubricant. Some applications do require more corrosion protection than lubricant can provide. In these instances, a galvanized finish is provided. Consult with WW's engineering department for more information on galvanized wire rope.

Wire Grade

Purple grade wire (improved plow steel) is a strong, tough, durable steel that combines great strength with high resistance to fatigue. Its minimum tensile strength varies from 223 to 258 ksi, depending upon wire diameter.

Purple Plus is WW's trade name for Extra Improved Plow (EIP) steel. Once a specialty grade, Purple Plus is now WW's grade for all standard wire rope. Minimum tensile strength varies from 245 to 284 ksi, depending upon wire diameter.

Royal Purple, or Extra Extra Improved Plow (EEIP) steel, is a grade used where a high breaking strength is required. This grade typically provides a breaking strength a minimum of 10% higher than Purple Plus and is found primarily as a standard grade for specialized wire rope. However, Royal Purple is available for standard wire ropes upon request.

Developed by WW for the federal government, Royal Purple Plus is the highest strength grade available to Bethlehem Wire Rope customers. **Royal Purple Plus** provides a breaking strength 35% higher than Purple Plus, and is available in WW's TRIPLE-PAC hoist rope.

It is the grade of wire which determines the nominal breaking strength for each diameter and construction. Note, the acceptance strength listed in the various tables for Bethlehem Wire Rope products is 2-1/2% below the nominal strengths listed.

Other grades are available to meet specific requirements. Some grades are covered by wire rope standards while others may be specially tailored. Consult WW's engineering department for further information.

Wire Rope Lay

The helix or spiral of the wires and strands in a rope is called the lay.

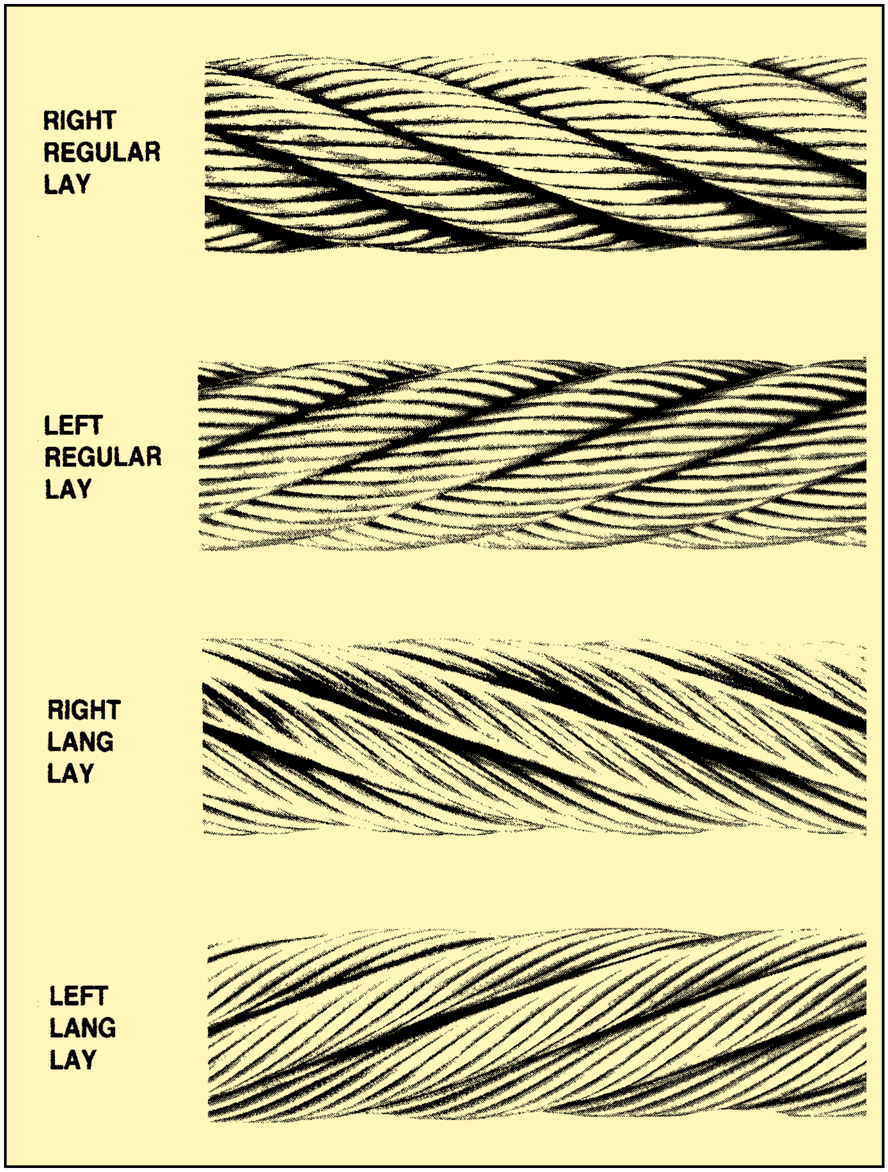
Regular lay denotes rope in which the wires are twisted in one direction, and the strands in the opposite direction to form the rope. The wires appear to run roughly parallel to the center line of the rope. Due to the difference in direction between the wires and strand, regular lay ropes are less likely to untwist or kink. Regular lay ropes are also less subject to failure from crushing and distortion because of the shorter length of exposed outer wires.

Lang lay is the opposite; the wires and strands spiral in the same direction and appear to run at a diagonal to the center line of the rope. Due to the longer length of exposed outer wires, Lang lay ropes have greater flexibility and abrasion resistance than do regular lay ropes. Greater care, however, must be exercised in handling and spooling Lang lay ropes. These ropes are more likely to twist, kink and crush than regular lay ropes.

Right or left lay refers to the direction in which the strands rotate around the wire rope. If the strands rotate around the rope in a clockwise direction (as the threads do in a right hand bolt), the rope is said to be right lay. When the strands rotate in a counterclockwise direction (as the threads do in a left hand bolt), the rope is left lay.

Right regular lay is furnished for all rope applications unless otherwise specified.

When a lay-length is used as a unit of measure, it refers to the linear distance a single strand extends in making one complete turn around the rope. Lay-length is measured in a straight line parallel to the center line of the rope, not by following the path of the strand. The appropriate time to replace a wire rope in service is frequently determined by counting the number of broken wires in the length of one rope lay.



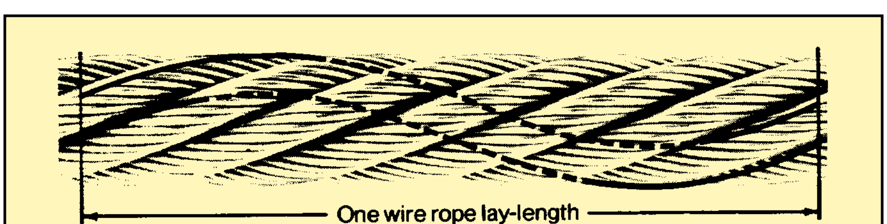
Preformed Wire Rope

Form-set is WW's trade name for preformed wire rope. Form-set means that the wires and strands have been preset during manufacture into the permanent helical form they take in the completed rope.

Unless otherwise specified, Bethlehem Wire Rope products are furnished Form-set.

Preformed wire rope has definite characteristics which are advantageous on most wire rope applications. Preforming greatly reduces internal stresses, eases rope handling, and gives more equal distribution of load on the wires and strands. Preformed rope runs smoother and spools more uniformly on a drum than non-preformed, has greater flexibility and gives longer service life in bending.

Preformed wires tend to remain in position after breaking. This reduces the tendency for them to protrude and damage adjacent wires. Because the wires do not protrude, we strongly suggest greater care and more thorough inspection to detect broken wires in a Form-set rope.



"LAY" AS A UNIT OF MEASURE

Wire Rope Core

Most wire ropes are supplied with either a fiber or steel core. The core is the foundation ot a wire rope. Its primary function is to support the wire strands of the rope, maintaining them in their correct relative positions during the operating life of the rope.

Fiber cores are ropes made from fibers formed into yarns, then into strands and finally into the finished core form. There are two general types of fiber: natural vegetable material, such as sisal, and synthetic filaments, such as polypropylene.

Steel cores may be an **independent wire rope** (IWRC) or, in the case of small diameter ropes and some rotation-resistant ropes, a **wire strand core** (WSC). These steel cores provide more support than fiber cores to the outer strands during the rope's operating life. Steel cores resist crushing, are more resistant to heat, reduce the amount of stretch, and increase the strength of the rope.

Wire Rope Lubrication

During the manufacture of Bethlehem Wire Rope products, WW applies heated lubricant to individual wires during the stranding operation. Upon customer request, additional lubricant may be applied during the closing operation as well.

WW utilizes two standard lubricants during the manufacture of general purpose ropes. WW's **N-lube** is a petrolatum-based lubricant used primarily in the manufacture of standard wire rope. This type of lubricant prevents rust and corrosion and lubricates against internal wear. **W-lube,** the standard lubricant used for specialty wire rope, is an asphaltic-based lubricant and rust preventative compound with a large percentage of water-displacing additives and corrosion inhibitors. W-lube is ideal for offshore and land cranes, and logging winch lines.

The Modified X-chart

Two factors governing most decisions in selecting wire rope are **abrasion resistance** and **resistance to bending fatigue.** A graphic presentation of the balance between these properties has traditionally been given by means of the X-chart. However, new designs of wire rope, such as 6-Pac and Triple-Pac, do not follow the X-chart model as they are designed to provide both abrasion resistance and resistance to bending fatigue. WW, therefore, developed the Modified X-chart.

To read the Modified X-chart, the position of each rope construction must be considered in relation to both the X and Y axes, or Abrasion Resistance and Resistance to Bending Fatigue, respectively. For example, the construction 6x41 (6x49) is in the upper left quadrant, ranking high on the bending fatigue scale. However, its position in abrasion resistance is very low. Therefore, it can be said that a 6x41 (6x49) construction offers excellent resistance to bending fatigue, but poor resistance to abrasion. At the other end of the spectrum is a 6x7 construction, located in the lower right hand corner of the chart. A 6x7 offers excellent abrasion resistance, but very poor resistance to bending fatigue.

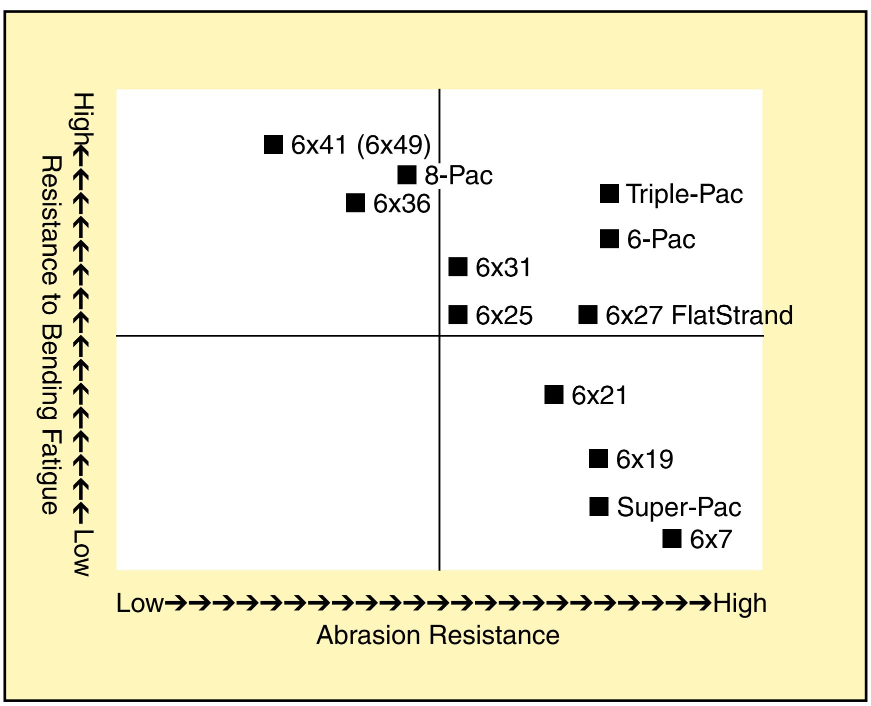
Rope Substitution

Many equipment manufacturers have established standard or "specified" wire ropes for their products.

Rope substitution is acceptable provided the end user follow the basic design specifications established by the equipment manufacturer:

- Always use the specified rope diameter.
- Ensure that the breaking strength of the substitute rope meets or exceeds that of the rope specified.
- Always substitute a rope with the same basic characteristics, such as rotation resistance.

ASME B30.5-1995 Addenda 5-1.7.2(a) states: ***The ropes shall be of a construction recommended by the rope or crane manufacturer or person qualified for that service.***



Suggested Wire Rope Constructions

APPLICATION	GENERAL CONDITIONS	SEVERE CONDITIONS
CRANES		
DROP BALLS		
Load Lines	6x25 RR IWRC	6-Pac
GANTRY CRANES		
Main Hoist	6x25 RR IWRC; 6x36 Class RR IWRC	6-Pac; 8-Pac; SFP 19
Auxiliary Hoist	6x25 RR IWRC	6-Pac; 8-Pac; SFP 19
Gantry crane types include: P&H, Demag, Kone and Kranco		
CONTAINER CRANE		
Hoist Lines	6x36 RR IWRC	8-Pac
Trolley Lines	6x36 RR IWRC	8-Pac
LOCOMOTIVE CRANES		
Main Hoist	6x25 RR IWRC	6-Pac; Triple-Pac
Auxiliary Hoist	6x25 RR IWRC	6-Pac; Triple-Pac
Boom Hoist	6x25 RR IWRC	6-Pac; Super-Pac
Tag Lines	6x33 Warrington Seale RR FC	n/a
OFFSHORE PEDESTAL CRANES (DRILLING RIGS, PLATFORMS and BARGES)		
Boom Hoist	6x25 RR IWRC	6-Pac; 6-Pac RV; Super-Pac
Hoist Lines	8x19 RR IWRC; 19x7	SFP 19
Auxiliary Lines	8x19 RR IWRC; 19x7	SFP 19
Offshore pedestal crane types include: Applied Hydraulics, Titan, Offshorecrane, Unit Mariner, Link-Belt, National, Weatherford, Manitowac, Manitex, Bucyrus-Erie, SeaKing, FAVCO, Liebherr, LeToureau, Nautilus, Clyde, American, Baker Marine and Skagit		
OVERHEAD TRAVELING CRANES		
Hoist Lines	6x19 Class RR IWRC; 6x36 Class RR IWRC	6-Pac; 8-Pac; SFP 19
ROUGH TERRAIN, ALL TERRAIN, TELESCOPIC and LATTICE BOOM TRUCK CRANES, LATTICE BOOM HYDRAULIC CRAWLERS and LATTICE BOOM FRICTION CRAWLERS		
Boom Hoist	6x25 RR IWRC; 6x36 Class RR IWRC	6-Pac; 6-Pac RV; Super-Pac
Hoist Lines	6x25 RR IWRC; 6x36 Class RR IWRC	6-Pac; 8-Pac; Triple-Pac; SFP 19
Auxiliary Lines	8x19 RR IWRC; 19x7	SFP 19
Boom Pendants	6x25 RR IWRC	6-Pac Triple-Pac
Rough terrain et al crane types include: Galion, Grove, Link-Belt, Lorain, Koehring, P&H, Tadano, Liebherr, Demag, American, Manitowac, Manitex, National, and Clark		
SIDE BOOM TRACTORS		
Hoist LInes	6x25 RR IWRC	6-Pac; Triple-Pac
Boom Hoist	6x25 RR IWRC	6-Pac; Triple-Pac
STIFF LEG DERRICKS and REVOLVING DERRICK CRANES		
Hoist LInes	6x25 RR IWRC	6-Pac; Triple-Pac
Auxiliary Lines	6x25 RR IWRC	6-Pac; Triple-Pac; SFP 19
Boom Hoist	6x25 RR IWRC	6-Pac; Triple-Pac; SFP 19
Derrick crane types include: AMCLYDE, American, Clyde and Manitowac		
TOWER CRANES		
Load Lines	SFP 19; SFP 35	SFP 35
Trolley Lines	6x25 RR IWRC	n/a
WHIRLEY CRANES		
Main Hoist	6x25 RR IWRC	6-Pac; SFP 19

APPLICATION	GENERAL CONDITIONS	SEVERE CONDITIONS
Auxiliary Hoist	6x25 RR IWRC	6-Pac; SFP 19
Boom Hoist	6x25 RR IWRC	6-Pac; Super Pac
Whirley crane types include: AMCLYDE, American, FAVCO and Clyde		
DREDGING		
DIPPER DREDGES		
Hoist Lines	6x19 Class RR IWRC; 6x36 Class RR IWRC	6-Pac; 6-Pac RV
Swinging and Backing Lines	6x19 Class RR IWRC; 6x36 Class RR IWRC	6-Pac
Spud Lines	6x19 Class RR IWRC; 6x36 Class RR IWRC	6-Pac
CLAMSHELL DREDGES		
Holding and Closing Lines	6x19 Class RR IWRC	6-Pac
Swing Lines	6x19 Class RR IWRC; 6x36 Class RR IWRC	6-Pac
Boom Hoist LInes	6x19 Class RR IWRC	6-Pac; 6-Pac RV; Super Pac
Stern or Anchor Lines	6x19 Class RR IWRC	6-Pac
Spud Lines	6x19 Class RR IWRC; 6x36 Class RR IWRC	6-Pac
LADDER or CHAIN BUCKET DREDGES		
Ladder Lines	6x19 Class RR or RL IWRC	6-Pac
Bow and Stern Lines	6x19 Class RR IWRC; 6x36 Class RR IWRC	6-Pac
Spud Lines	6x19 Class RR IWRC; 6x36 Class RR IWRC	6-Pac
SUCTION DREDGES		
Ladder Lines	6x19 Class RR or RL IWRC	6-Pac
Swing Lines	6x19 Class RR IWRC	6-Pac
Spud Lines	6x19 Class RR IWRC; 6x36 Class RR IWRC	6-Pac
Pontoon Lines	6x19 Class RR IWRC	6-Pac
EXCAVATING		
POWER SHOVELS		
Hoist Lines	6x25 RR or RG IWRC; 6x36 Class RG IWRC	6-Pac
Crowd and Retract Lines	6x25 RR or RG IWRC; 6x36 Class RG IWRC	6-Pac; 6-Pac RV
Boom Lines	6x25 RR or RG IWRC; 6x36 Class RG IWRC	6-Pac; 6-Pac RV
Trip Lines	6x19 Warrington RR FC; 6x33 Warrington Seale RR FC	n/a
DRAGLINE EXCAVATORS		
Draglines	6x19 Class RG IWRC	6-Pac
Hoist Lines	6x19 Class RR or RG IWRC	6-Pac; 6-Pac RV
Boom Lines	6x19 Class RR or RG IWRC; 6x36 Class RG IWRC	6-Pac; 6-Pac RV
Dump Lines	6x25 RR or RG IWRC	6-Pac; 6-Pac RV
CLAMSHELLS		
Hoist Lines	6x19 Class RR IWRC; 19x7	6-Pac; Triple-Pac; SFP 19
Holding and Closing Lines	6x19 Class RR or RG IWRC; 6x36 Class RR IWRC or FC	6-Pac; 6-Pac RV
Boom Lines	6x25 RR IWRC; 6x26 RV IWRC	6-Pac; 6-Pac RV; Super-Pac
Tag Lines	6x33 Warrington Seale RR FC	n/a
CARRY-ALL SCRAPERS and WAGONS		
Hoist and Dump Lines	6x25 RR or RG IWRC; 6x36 Class RR or RG IWRC	6-Pac
TRENCH HOES, DITCHERS and PULL SHOVELS		
Digging Lines	6x19 Class RG IWRC	6-Pac
Hoist Lines	6x25 RR IWRC; 6x26 Warrington Seale RR IWRC	6-Pac
Boom Lines or Shear-Leg Lines	6x26 RR IWRC	6-Pac

Suggested Wire Rope Constructions

APPLICATION	GENERAL CONDITIONS	SEVERE CONDITIONS
SLACKLINE EXCAVATORS		
Track Lines	6x19 Class RG FC; flattened strand RG FC	6-Pac; 6-Pac RV
Load or Unhaul Lines	6x19 Class RR IWRC	6-Pac
Tension or Track Adjusting Lines	6x25 RR IWRC	6-Pac
HOIST and WINCHES		
Construction Hoists	6x19 Class RR IWRC; 6x36 Class RR ISRC	6-Pac
Electric and Air Hoists	6x19 Warrington RR FC; 6x36 Class RR FC; 19x7; SFP 19	n/a
Winches	6x19 Class RR IWRC; 6x36 Class RR IWRC	6-Pac
LOGGING		
EASTERN		
Winch Lines	6x26 Warrington Seale RR IWRC	Super-B
Chokers	6x26 Warrington Seale RR IWRC	n/a
WESTERN		
Archlines	6x26 Warrington Seale RR IWRC	Super-B; Super-Pac
Boom Loaders	6x26 Warrington Seale RR IWRC	Super-B; Super-Pac
Chokers	6x26 Warrington Seale RR IWRC	Super-B; Super-Pac
Haulbacks	6x19 Seale RR IWRC; 6x26 Warrington Seale RR IWRC	Super-B; Super-Pac
Helicopter Chokers	Skybrite	n/a
Mainlines	6x26 Warrington Seale RR IWRC	Super-B; Super-Pac
Sawmill Carriage	6x25 RR IWRC	Super-B; Super-Pac
Skylines	6x19 Seale RR IWRC; 6x26 Warrington Seale RR IWRC	Super-B; Super-Pac
Strawlines	6x19 Seale RR IWRC	Super-B; Super-Pac
Triple Drum Lines	6x26 Warrington Seale RR IWRC	Super-B; Super-Pac
Winch Lines	6x26 Warrington Seale RR IWRC	Super-B; Super-Pac
OILFIELD AND MARINE		
Anchor Lines	6x19 Class RR IWRC; 6x36 Class RR IWRC	galvanized, Bethpac, Z-nodes
Coring, Sand & Swabbing Lines	6x7 FC	galvanized
Diving Bells	19x7; SFP 19	SFP 35
Marcellus Shale Drill Lines	6x21 LR FC	
Mooring Lines	6x19 and 6x36 Classes RR IWRC; galvanized strand	galvanized rope, Bethpac, Z-nodes
Riser Tensioner Lines	6x36 Class RR IWRC	Bethpac
Rotary Drill Lines	6x19 Seale RR IWRC; 6x26 Warrington Seale RR IWRC	Bethpac
Tow Lines	6x36 Class RR IWRC	galvanized
Tubing Lines	6x26 Warrington Seale RR IWRC	6x31Super-B, Super-Pac
Work Wire, Chain Chasers	6x19 Class RR IWRC; 6x36 Class RR IWRC	galvanized
STEEL MILL		
Bell Ropes	6x25 RR IWRC	6-Pac
Car Puller, Spotter, Retarder Rope	6x19 Class RR IWRC or FC	6-Pac
Ladle Cranes	6x36 Class RR IWRC	6-Pac; Triple-Pac
Ore Bridges and Unloaders	6x19 Class RR IWRC	6-Pac
Skip Hoists	6x19 Class RR or RG FC; flattened strand RG FC	Triple-Pac
Stripper and Soaking Pit Cranes	6x36 Class RR IWRC	6-Pac; Triple-Pac

LR = Left regular lay; RR = Right regular lay; RG = Right lang lay; RV = Reverse lay; FC = Fiber core; IWRC = Independent wire rope core

BXL, or plastic infusion, may be added to many standard and specialty wire rope constructions, and is therefore not listed as a recommendation under Severe Conditions. Refer to Specialty Applications: BXL for further information.

In some instances, WW specifies class and not a specific construction. This is due to multiple diameters used on a particular application, and/or multiple constructions suitable for the application. For more information, please contact WW's sales or engineering department.

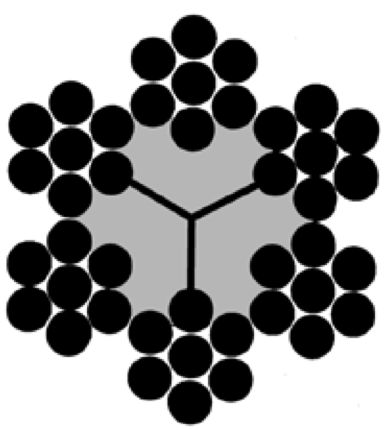
Refer to product data for grades.

6x7 Class Wire Rope

This construction is used where ropes are dragged on the ground or over rollers, and resistance to wear and abrasion are important factors. The wires are quite large and will stand a great deal of wear. In fact, this construction is sometimes called "coarse laid" because of the large wires.

The 6x7 is a stiff rope and needs sheaves and drums of large size. It will not withstand bending stresses as well as ropes with smaller wires. Because of the small number of wires, with the resulting higher percentage of load carried by each wire, a larger factor of safety should be considered with 6x7 ropes than with ropes having a larger number of wires.

Strands: 6
Wires per strand: 7
Core: Fiber core
Standard grade(s): Purple
Lay: Regular or Lang
Finish: Bright or galvanized



Rope Diameter		Approx. Weight (lb./ft.)	Nominal Strength*, tons (bright or drawn galvanized**)
inches	mm.		Purple
1/4	6.5	0.094	2.64
5/16	8.0	0.15	4.10
3/8	9.5	0.21	5.86
7/16	11.0	0.29	7.93
1/2	13.0	0.38	10.3
9/16	14.5	0.47	13.0
5/8	16.0	0.57	15.9
3/4	19.0	0.84	22.7
7/8	22.0	1.15	30.7
1	26.0	1.50	39.7
1-1/8	29.0	1.90	49.8
1-1/4	32.0	2.34	61.0
1-3/8	35.0	2.82	73.1
1-1/2	38.0	3.38	86.2

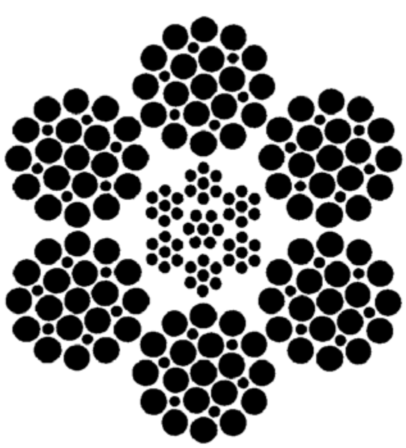
**Galvanizing: For Class A galvanized wire rope, deduct 10% from the nominal strength shown.

6x19 Class Wire Rope

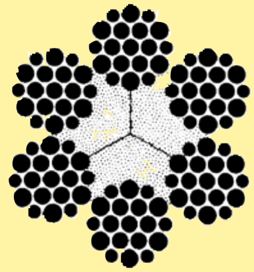
Strands: 6
Wires per strand: 19 to 26
Core: IWRC or fiber core
Standard Grade: Purple Plus
Lay: Regular or Lang
Finish: Bright or galvanized

The 6x19 Classification of wire rope is the most widely used. With its good combination of flexibility and wear resistance, rope in this class can be suited to the specific needs of diverse kinds of machinery and equipment.

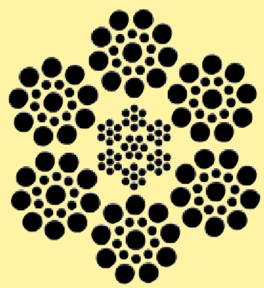
The 6x19 Seale construction, with its large outer wires, provides great ruggedness and resistance to abrasion and crushing. However, its resistance to fatigue is somewhat less than that offered by a 6x25 construction. The 6x25 possesses the best combination of flexibility and wear resistance in the 6x19 Class due to the filler wires providing support and imparting stability to the strand. The 6x26 Warrington Seale construction has a high resistance to crushing. This construction is a good choice where the end user needs the wear resistance of a 6x19 Class Rope and the flexibility midway between a 6x19 Class and 6x37 Class rope.



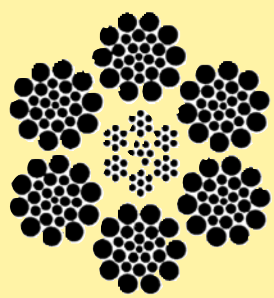
6x25 Filler Wire with IWRC



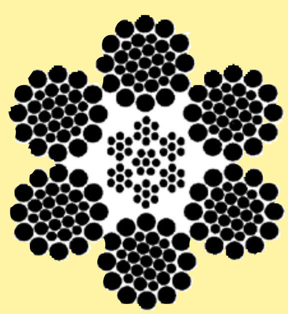
6x19 Warrington with fiber core



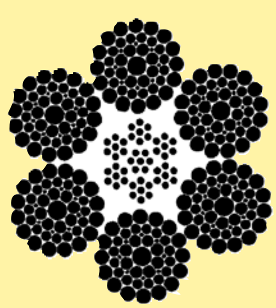
6x19 Seale with IWRC



6x26 Warrington Seale with IWRC



6x31 Warrington Seale with IWRC



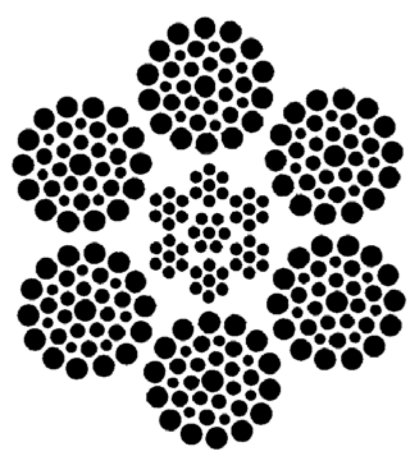
6x49 Filler Wire Seale with IWRC

6x36 Class Wire Rope

Strands: 6
Wires per strand: 27 to 49
Core: IWRC or fiber core
Standard Grade: Purple Plus
Lay: Regular or Lang
Finish: Bright or galvanized

The 6x36 Class of wire rope is characterized by the relatively large number of wires used in each strand. Ropes of this class are among the most flexible available due to the greater number of wires per strand, however their resistance to abrasion is less than ropes in the 6x19 Class.

The designation 6x36 is only nominal, as in the case with the 6x19 Class. Improvements in wire rope design, as well as changing machine designs, have resulted in the use of strands with widely varying numbers of wires and a smaller number of available constructions. Typical 6x37 Class constructions include 6x33 for diameters under 1/2", 6x36 Warrington Seale (the most common 6x37 Class construction) offered in diameters 1/2" through 1-5/8", and 6x49 Filler Wire Seale over 1-3/4" diameter.



6x36 Warrington Seale IWRC

6x19 and 6x36 Classes Technical Data

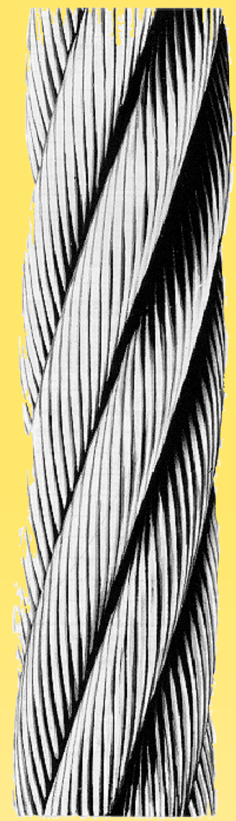
6x19 Class

6x19 Seale
6x19 Warrington
6x21 Filler Wire Type U
6x21 Seale
6x25 Filler Wire Type W
6x25 Seale
6x26 Warrington Seale

Rope Diameter		Approx. Weight (lb./ft.)		Nominal Strength*, tons (bright or drawn galvanized**)		
				Royal Purple	Purple Plus	
inches	mm.	Fiber Core	IWRC	IWRC	Fiber Core	IWRC
1/4	6.5	0.11	0.12	3.74	3.01	3.40
5/16	8.0	0.16	0.18	5.80	4.69	5.27
3/8	9.5	0.24	0.26	8.30	6.71	7.55
7/16	11.0	0.32	0.35	11.2	9.10	10.2
1/2	13.0	0.42	0.46	14.6	11.8	13.3
9/16	14.5	0.53	0.58	18.5	14.9	16.8
5/8	16.0	0.66	0.72	22.7	18.4	20.6
3/4	19.0	0.95	1.04	32.4	26.2	29.4
7/8	22.0	1.29	1.41	43.8	35.4	39.8
1	26.0	1.68	1.85	56.9	46.0	51.7
1-1/8	29.0	2.13	2.34	71.5	57.9	65.0
1-1/4	32.0	2.63	2.89	87.9	71.1	79.9
1-3/8	35.0	3.18	3.49	106	85.5	96
1-1/2	38.0	3.78	4.16	125	101	114
1-5/8	42.0	4.44	4.88	146	118	132
1-3/4	45.0	5.15	5.66	169	136	153
1-7/8	48.0	5.91	6.49	192	155	174
2	52.0	6.73	7.39	217	176	198
2-1/8	54.0	7.60	8.34	243	197	221
2-1/4	58.0	8.52	9.35	272	220	247
2-3/8	60.0	9.49	10.4	301	244	274
2-1/2	64.0	10.5	11.6	332	269	302
2-3/4	70.0	12.7	14.0	397	321	361

**Galvanizing: For Class A galvanized wire rope (EIP grade only), deduct 10% from the nominal strength shown.

Technical data for the above listed constructions are the same and are detailed in the table. For further information on additional constructions and diameters, contact WW's customer service department.



6x36 Class

6x31 Warrington Seale
6x33
6x36 Warrington Seale
6x41 Warrington Seale
6x43 Filler Wire Seale
6x49 Filler Wire Seale

Alternate Lay Wire Rope

Alternate Lay, sometimes referred to as reverse lay, is a stranded rope where the type of lay of the outer strands is alternately regular lay followed by lang lay such that three of the outer strands are regular lay and three are lang lay.

Alternate lay wire rope has the extra flexibility of lang lay in combination with the structural stability of regular lay. It unites the best features of both types of wire rope.

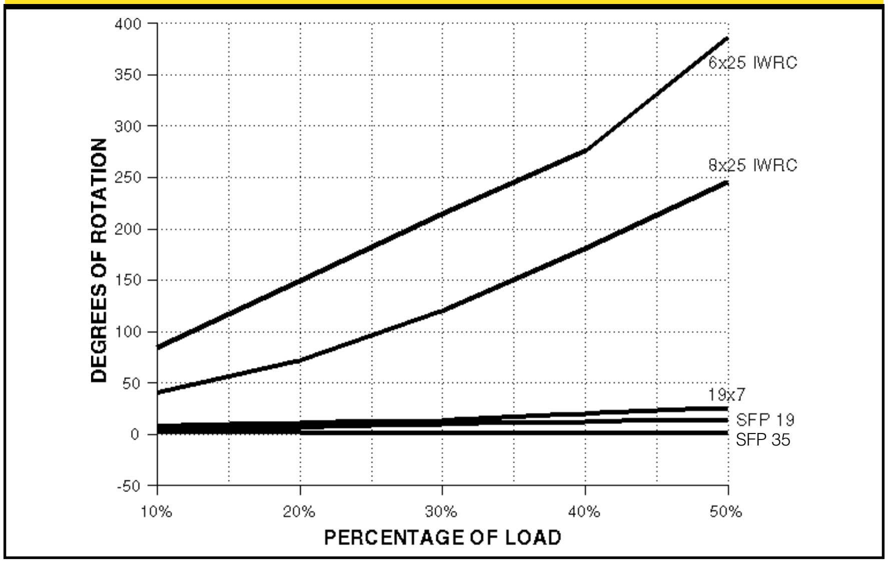
Alternate lay is made with relatively large outer wires to provide increase of abrasion resistance to scrubbing against sheaves and drums. Finer inside wires and flexibility enable alternate lay ropes to absorb severe bending stresses. It is well suited to winding applications where abrasion and crushing can occur.

Alternate lay wire rope applications include boom hoists and nume rous types of excavating equipment like clamshells, shovels, cranes, winches and scrapers.

Rope Diameter		Approx. Weight (lb./ft.)	Nominal Strength tons
			Purple Plus
inches	mm.		
1/2	13.0	0.46	13.3
9/16	14.5	0.59	16.8
5/8	16.0	0.72	20.6
3/4	19.0	1.04	29.4
7/8	22.0	1.42	39.8
1	26.0	1.85	51.7
1-1/8	29.0	2.34	65.0
1-1/4	32.0	2.89	79.9

Strands: 6
Wires per strand: 26
Core: IWRC
Standard Grade: Purple Plus
Lay: Combination
Finish: Bright

Rotational Property Comparison



In certain instances the use of rotation-resistant wire rope is necessary to provide rotational stability to the lifted load. In general, the use of these wire ropes is limited to those situations where it is impractical to:

1. Use a tag line.
2. Relocate rope dead end.
3. Increase sheave sizes.
4. Eliminate "odd-part" reeving.
5. Significantly reduce rope loading and rope fall length.

Rotation-resistant wire ropes have less of a tendency to unlay when loaded than do conventional wire ropes. This results in improved rotational stability to the lifted load. Rotation-resistant wire ropes are designed in such a way that the rotational force of the outer strands is partially counteracted by the rotational force of the inner strands or core when the rope is subjected to a load.

The chart compares the rotational properties of rotation-resistant ropes with a standard 6x25 wire rope. The rotation-resistant ropes far surpass the rotational stability of a conventional 6x25 IWRC wire rope on both short and long falls.

Safety Design Factors

ASME B30.5 specifies that rotation-resistant ropes have a safety design factor of five or greater. The required strength design factor of rotation-resistant rope becomes very important from the standpoint of maintaining the inherent low rotation of the rope and eliminating any tendency to overload the inner core, thereby causing a reduction in rope strength.

Handling & Installation

Precautions should be followed when using rotation-resistant wire rope. The rope ends must be properly seized and secured (refer to Handling and Installation: Seizing Wire Rope) and cut with a saw or impact hammer to prevent unlaying of the strands.

Attachment of end fittings must be done with care to prevent kinking or unlaying of rope, which harms the rotational balance of the rope.

Due to the opposite lay direction of the inner core and outer strand layers in rotation-resistant ropes, care should be taken to avoid shockloading. Shockloading will result in distortion of the rope structure, causing birdcaging, core protrusion, etc. Due to the potential for complete rope failure, shockloaded wire ropes must be immediately removed from service.

Swivels

Operation of 8x25, 19x7 and SPF 19 rotation-resistant wire ropes with a swivel is not recommended by WW. The use of a swivel allows the inner core to twist tighter, resulting in a significant reduction in rope strength, possibly leading to premature rope failure. A swivel may be used as a temporary device only during the initial installation period to help eliminate any installation-induced twisting or cabling.

The swivel must be removed from the reeving after rope installation is completed and before the crane begins operation. A swivel may be used with SFP 35 Rotation Resistant Ropes.

The rated strengths of the 8x19 Class and 19x7 wire ropes are less than wire ropes in the 6x19 and 6x37 Classes. Larger sheaves are required in order to achieve comparable fatigue life. *Refer to Technical Information: Effect of Sheave Size* for further information on proper sheave sizes.

8x19 Classification Rotation-Resistant

The 8x19 Classification rotation-resistant ropes are recommended for hoisting unguided loads with a single-part or multipart line.

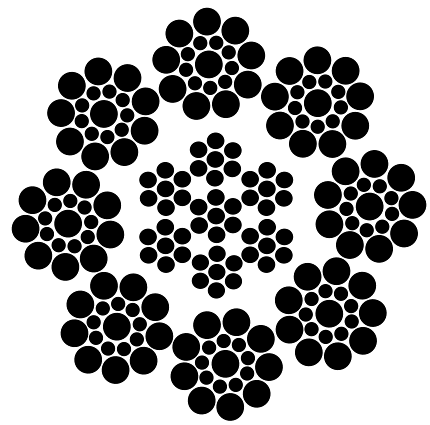
The eight outer strands are manufactured in right lay, with the inner strands being left lay.

These ropes are slightly stronger and significantly more rugged than the 19x7 construction. However, the rotation-resistant properties of the 8x19 rotation-resistant ropes are much less than those of the 19x7 construction.

These ropes are manufactured in right regular lay in the 8x19 Seale and 8x25 Filler Wire constructions.

Rope Diameter		Approx. Weight (lb./ft.)	Nominal Strength (tons)*
inches	mm.		Purple Plus
7/16	11.0	0.36	9.0
1/2	13.0	0.47	11.6
9/16	14.5	0.60	14.7
5/8	16.0	0.73	18.1
3/4	19.0	1.06	25.9
7/8	22.0	1.44	35.0
1	26.0	1.88	45.5
1-1/8	29.0	2.39	57.3
1-1/4	32.0	2.94	70.5
1-3/8	35.0	3.56	84.9
1-1/2	38.0	4.24	100.0

Strands: 8
Wires per strand: 19 to 25
Core: IWRC
Standard grade(s): Purple Plus
Lay: Right Regular
Finish: Bright



19x7 Rotation-Resistant

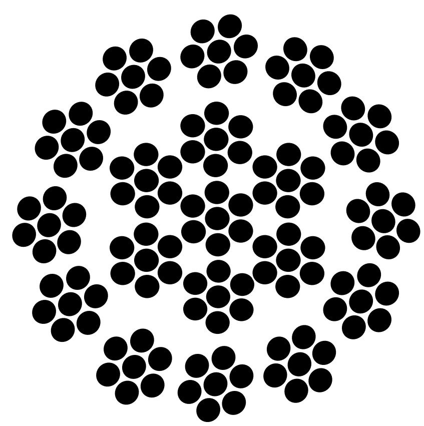
19x7 is recommended for hoisting unguided loads with a single-part line.

The rotation-resistant properties of this rope are secured by two layers of strands. The inner strands are left lay, while the 12 outer strands are right lay, which enables one layer to counteract the other layer's rotation.

The rotation-resistant characteristics of the 19x7 wire ropes are superior to those of the 8x19 Class wire ropes.

Rope Diameter		Approx. Weight (lb./ft.)	Nominal Strength (tons)*
inches	mm.		Purple Plus
7/16	11.0	0.350	8.33
1/2	13.0	0.450	10.80
9/16	14.5	0.580	13.60
5/8	16.0	0.710	16.80
3/4	19.0	1.020	24.00
7/8	22.0	1.390	32.50
1	26.0	1.820	42.20
1-1/8	29.0	2.300	53.10
1-1/4	32.0	2.840	65.10
1-3/8	35.0	3.430	78.40
1-1/2	38.0	4.080	92.80

Strands: 19
Wires per strand: 7
Core: WSC
Standard grade(s): Purple Plus
Lay: Regular
Finish: Bright



Super Flex Pac 19

SFP 19 is recommended for both multipart load and single-part fast line applications where rotational stability of the lifted load is needed, such as for use as a long fall on off-shore pedestal cranes, rough and all terrain cranes, and crawler cranes. SFP 19 provides:

Fatigue Resistance. Improved fatigue properties are derived through the combination of the flexible 19x19 construction and die drawn strands. The drawn strand surfaces minimize the interstrand and interlayer nicking that take place in round rotation-resistant ropes.

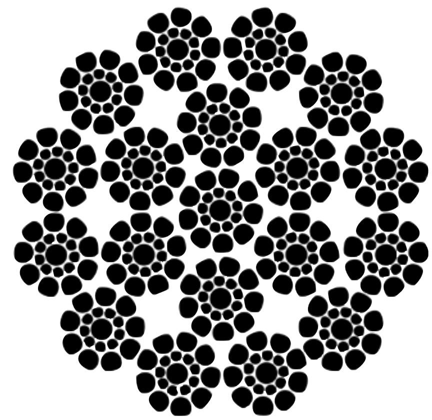
Abrasion Resistance. Die drawn ropes provide improved abrasion resistance as compared with round wire ropes because of the greater wire and strand bearing surfaces contacting sheaves and drums.

Resistance to Drum Crushing. SFP 19 wire ropes are resistant to the effects of drum crushing due to the compacted strands and smoothness of the rope surface.

Rope Diameter		Approx. Weight (lb./ft.)	Nominal Strength (tons)*
inches	mm.		Royal Purple
1/2	13.0	0.54	14.6
9/16	14.5	0.69	18.5
5/8	16.0	0.83	22.7
3/4	19.0	1.19	32.4
7/8	22.0	1.62	43.8
1	26.0	2.12	56.9
1-1/8	29.0	2.68	71.5
1-1/4	32.0	3.31	87.9
1-3/8	35.0	4.01	106.0
1-1/2	38.0	4.77	125.0

Note: 5/8 and below 19x7 construction; 3/4 and larger 19x19 construction

Strands: 19
Wires per strand: 7/19
Core: WSC
Standard grade(s): Royal Purple
Lay: Right Regular
Finish: Bright



Super Flex Pac 35

SFP 35 is a rotation-resistant rope of high strength that can resist block twist in long falls.

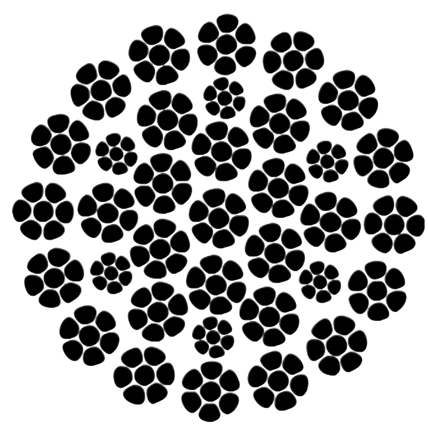
SFP 35 provides: **Superior Rotation Resistance**—the SFP 35 rope is the most rotation resistant rope manufactured by WW. Due to its rotation-resistant properties, SFP 35 may be used with a swivel in both single part and multipart reeving.

High Strength. WW's compaction process provides a high strength rope which exceeds EEIP nominal breaking strength.

Application. SFP 35 excels in crawler and truck-type crane load lines, and tower crane hoist ropes.

Flexibility. SFP 35's multiple strand construction provides increased flexibility which improves service life and high speed spooling. The compacted multiple strand construction also reduces sheave and drum abrasion and provides excellent resistance to drum crushing.

Strands: 35
Wires per strand: 7
Core: WSC
Standard grade(s): 2160 N/mm^2
Lay: Right Regular
Finish: Bright



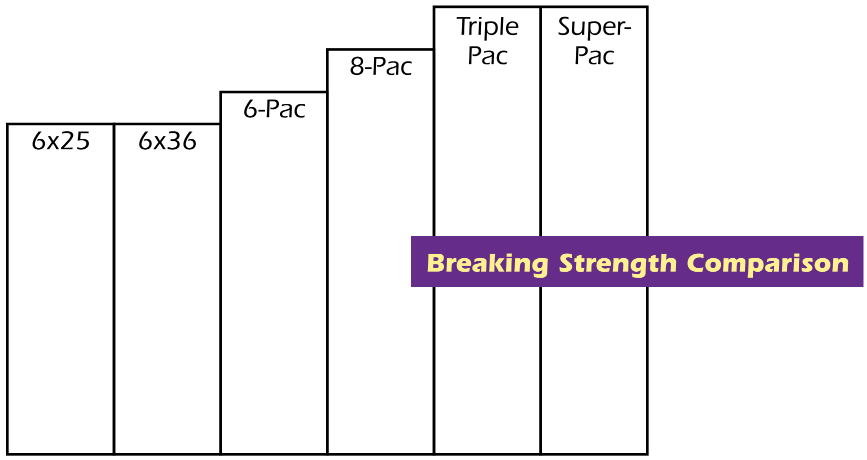
Rope Diameter		Approx. Weight		Nominal Strength	
mm	inches	(kg/m)	(lb/ft)	(kN)*	(tons)
19		1.79		344	
	3/4		1.21		38.70
22		2.40		466	
	7/8		1.65		53.00
	1		2.15		70.00
26		3.36		660	
28		3.90		758	
	1 1/8		2.73		86.90

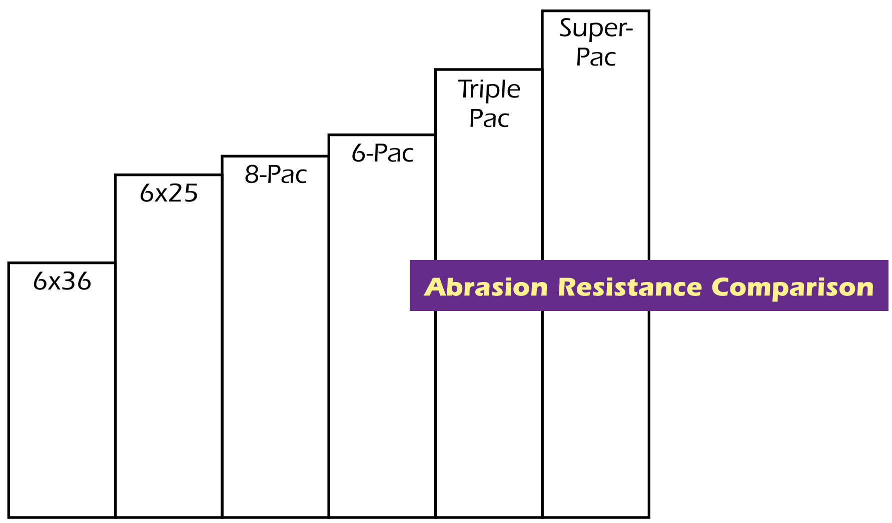
Specialized Wire Rope

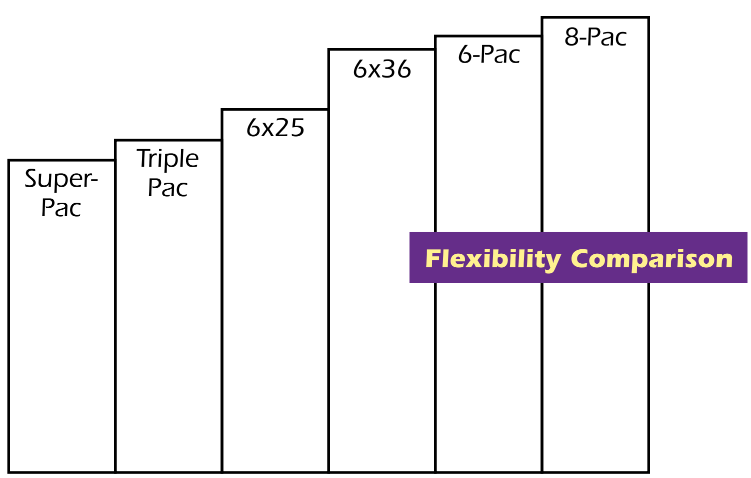
The charts shown to the right are meant to serve as a quick reference guide in selecting a specialized wire rope.

The increased strengths of the specialized ropes are derived from greater metallic areas. Whether the greater metallic areas are caused by die drawn strands (6-Pac) or a combination of die drawn strands and swaging (Super-Pac and Triple-Pac), these manufacturing processes create denser rope cross sections, thus increasing the ropes' breaking strengths. Also contributing to the increase in strength for the die drawn strand ropes is the flat, smooth finish to the strands which eliminates inter-strand nicking and enables the load placed upon the wire rope to increase without causing internal damage.

Abrasion resistance and flexibility are determined by two factors—outer wire size and method of compaction. Generally, the larger the outer wire size, the greater the abrasion resistance. For example, a 6x25 wire rope is manufactured with an outer wire size greater than that of a 6x36. Therefore, the 6x25 wire rope is more resistant to abrasion. Abrasion resistance is also determined by compaction. The greater the compaction, the greater the abrasion resistance, as in the case of Super-Pac and Triple-Pac. Conversely, wire ropes manufactured with small wire sizes offer greater flexibility than those with large outer wires. Again using 6x25 and 6x36 as an example, the 6x36 with smaller outside wires is clearly more flexible. Further, compaction may either enhance or hinder flexibility. Die drawn strands (6-PAC) enhance flexibility due to the strands' flat surface areas reducing internal resistance, enabling the strands to better move in conjunction with each other. Swaging, on the other hand, hinders flexibility, as evidenced by Super-Pac and Triple-Pac.







6-PAC

6-PAC is recommended for use where the rope is subjected to heavy use or where conditions are extremely abusive, such as offshore pedestal, crawler and lattice boom equipped truck crane boom hoist applications. 6-PAC is also recommended for winch lines, overhead cranes, multipart hoist lines where rotation-resistant ropes are not required, and other applications where flexibility, high strength and resistance to crushing are important, and a cost-effective 6-strand rope is desired.

6-PAC provides:

Fatigue Resistance. Improved fatigue properties are derived from the combination of 6-PAC's flexible constructions and the compacted strands. The compacted strand surface minimizes the interstrand and interlayer nicking that take place in standard 6-strand ropes.

Abrasion Resistance. 6-PAC's compacted strand design provides improved abrasion resistance as compared to standard 6-strand ropes because of the increased wire and strand surfaces contacting sheaves and drums.

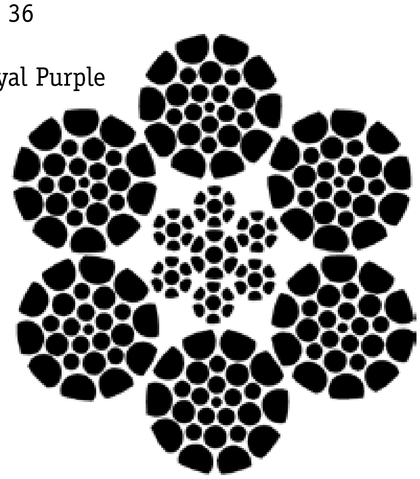
Flexibility. 6-PAC's design provides increased flexibility, making it easy to install, and 6-PAC also offers better spooling at high line speeds.

Resistance To Multilayer Drum Crushing. 6-PAC dramatically increases the amount of wire contact with the drums and sheaves, reducing the wire rope, sheave and drum wear normally associated with standard wire rope. Damage at the crossover points is also reduced.

Rope Diameter		Standard Constructions	Approx. Weight (lb./ft.)	Nominal Strength (tons)*
inches	mm.			Royal Purple
3/8	9.5	6x19 Seale	0.285	8.3
7/16	11.0	6x19 Seale	0.388	11.2
1/2	13.0	6x26	0.503	14.6
9/16	14.5	6x26	0.642	18.5
5/8	16.0	6x26	0.795	22.7
3/4	19.0	6x31	1.143	32.4
7/8	22.0	6x31	1.547	43.8
1	26.0	6x31	2.075	56.9
1-1/8	29.0	6x31	2.575	71.5
1-1/4	32.0	6x31	3.169	87.9
1-3/8	35.0	6x36	3.758	106.0
1-1/2	38.0	6x36	4.564	125.0
1-5/8	41.3	6x36	5.356	146.0
1-3/4	45.5	6x36	6.212	169.0

For Bethpac, or 6-PAC over 1-3/4" diameter, please refer to WW's Bethlehem Mining Products catalog, or contact our customer service department.

Strands: 6
Wires per strand: 19 to 36
Core: IWRC
Standard grade(s): Royal Purple
Lay: Right Regular
Finish: Bright



8-PAC

8-PAC is recommended for hoist ropes for steel mill ladle cranes and hoist and trolley ropes for container cranes, or other hoisting applications with heavy duty cycles or where severe bending occurs.

Other features of 8-PAC include:

Superior Performance. 8-PAC has higher breaking strength and gives superior performance in difficult hoisting applications compared to standard 6-strand and 6-strand compacted ropes.

Abrasion Resistance. 8-PAC compacted strand design provides improved abrasion resistance as compared to standard 6 and 8 strand ropes because of the increased wire and strand surfaces contacting the sheaves and drums.

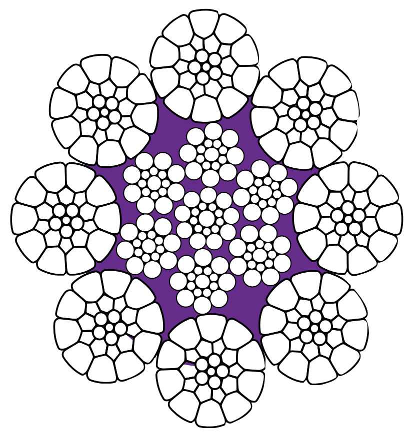
Superior Flexibility. 8-PAC is significantly more flexible than standard 6 and compacted 6 strand ropes with better spooling and longer service life.

Resistance To Multilayer Drum Crushing. 8-PAC's plastic-filled (BXL) core offers increased resistance to crushing through better support of the outer strands.

Rope Diameter inches	Standard Construction	Approx. Weight (lb/ft)	Minimum Breaking Strength (net tons)
5/8	8x26 WS	0.80	25.0
3/4	8x26 WS	1.17	36.0
7/8	8x26 WS	1.60	48.3
1	8x26 WS	2.10	62.8
1 1/8	8x26 WS	2.63	79.0
1 1/4	8x31 WS	3.26	98.0

NOTE: Other sizes available

Strands: 8
Wires per strand: 19 to 36
Core: Plastic filled (BXL)
Standard grade(s): Royal Purple
Lay: Right
Finish: Bright



SUPER-PAC

SUPER-PAC is a double compacted product ideal for applications where abrasion and drumcrushing are an issue. When compared with standard ropes, SUPER-PAC provides: Better resistance to multi-layer drum crushing. SUPER-PAC dramatically reduces the damage at cross over points on smooth face drums, such as those found on many boom hoist systems on mobile cranes. This is achieved by compaction of the strands and the rope, making a tough but flexible product.

Abrasion Resistance. The compaction process also increases the contact between the rope and the drum and sheaves, reducing sheave and drum wear.

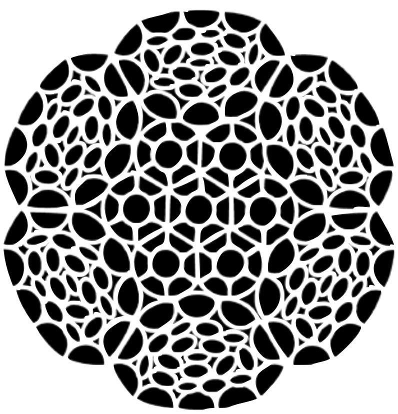
Super Strength. The double compaction process also increases the minimum breaking strength of standard EIP rope more than 20%.

Superior Fatigue Resistance. SUPER-PAC is engineered for overall performance, its wire tensile strength being the key to its superior fatigue resistant properties. In addition to contribution to SUPER-PAC's EEEIP breaking strength, the wire used in the manufacture of SUPER-PAC remains ductile, minimizing the occurrences of external and internal wire breaks caused by operating stresses.

Application. SUPER-PAC is ideal for all types of boom hoist and lowering ropes.

Rope Diameter		Approx. Weight	Nominal Strength
inches	mm	(lb/ft)	(tons)
5/8	16	0.995	29
3/4	19	1.43	40
7/8	22	1.92	52
1	26	2.42	68
1-1/8	29	2.96	85
1-1/4	32	3.51	102

Strands: 6
Wires per strand: 26/31
Core: IWRC
Standard grade(s): Royal Purple Plus
Lay: Right Regular
Finish: Bright



TRIPLE-PAC

TRIPLE-PAC was developed for the most demanding hoist applications. TRIPLE-PAC offers the extra high strength and crushing resistance needed for applications such as boom hoist ropes, boom pendants and multi-part load lines.

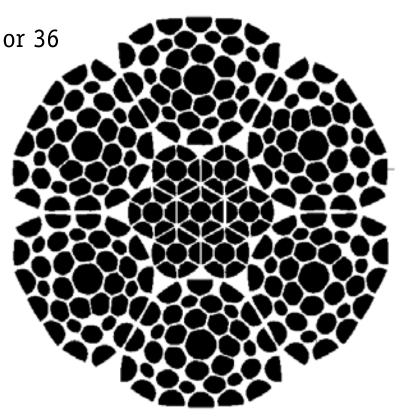
TRIPLE-PAC provides **superior abrasion and fatigue resistance** as compared with most compacted ropes due to WW's unique design of compacting the IWRC, individual strands and the rope itself. Other benefits include:

High Strength. TRIPLE-PAC is designed to provide a nominal strength of **35% above EIP**. WW achieves this strength through selected grades of steel and TRIPLE-PAC's unique design and manufacturing processes.

Superior Resistance to Multi-layer Drum Crushing. TRIPLE-PAC provides superior resistance to crushing through its design. Its triple compaction provides a denser cross section, enabling the rope to withstand the rigors of multilayer spooling. Damage at the cross over points is also significantly reduced. In addition, TRIPLE-PAC's design increases the amount of wire contact with sheaves and drums, reducing wire rope, drum and sheave wear.

Rope Diameter		Standard Constructions	Approx. Weight (lb./ft.)	Nominal Strength (tons)*
inches	mm.			Royal Purple Plus
7/16	11.0	6x26	.412	13.8
1/2	13.0	6x26	.543	18.0
9/16	14.5	6x26	.681	22.7
5/8	16.0	6x26	.858	27.8
3/4	19.0	6x31or 36	1.30	39.7
7/8	22.0	6x31or 36	1.72	53.7
1	26.0	6x31or 36	2.30	69.8
1-1/8	29.0	6x31or 36	2.89	87.8
1-1/4	32.0	6x31or 36	3.54	107.9
1-3/8	35.0	6x31or 36	4.04	129.6
1-1/2	38.0	6x31or 36	4.99	153.9

Strands: 6
Wires per strand: 26/31 or 36
Core: IWRC
Standard grade(s):
Royal Purple Plus
Lay: Right Regular



BXL

BXL is infused with a specially-engineered polymer, creating a well-balanced matrix. BXL is recommended for numerous hoist, marine and logging rope applications. BXL provides:

Fatigue Resistance. Improved fatigue resistance is derived from the cushionin g and dampening effect of the polymer on the wires and strands. BXL also evenly distributes stresses which may lead to fatigue breaks.

Abrasion Resistance. The polymer acts as a barrier between the individual strands, preventing penetration of any adverse material. BXL distributes and reduces contact stresses between the rope and sheave, reducing wire rope wear.

Resistance To Multilayer Drum Crushing. BXL's smooth profile evenly distributes crushing pressures from the overlying layers of rope in multilayer drum winding applications.

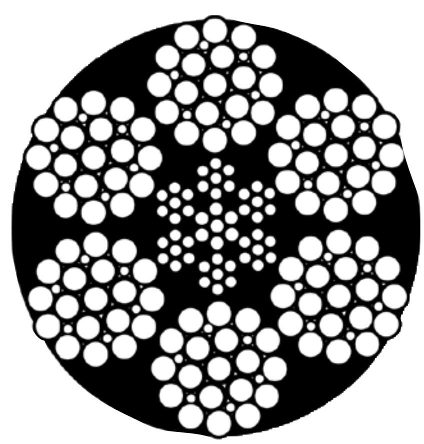
Extended Sheave And Drum Service Life. BXL minimizes corrugation and wear normally associated with standard rope usage by restricting water and dirt penetration and eliminating pickup of abrasive materials.

Clean Handling. The exterior rope surface is free from the grease normally applied to standard ropes.

Rope Diameter		Approx. Weight (lb./ft.)	Nominal Strength (tons)*
inches	mm.		Purple Plus
3/8	9.5	0.27	7.55
7/16	11.0	0.37	10.2
1/2	13.0	0.49	13.3
9/16	14.5	0.61	16.8
5/8	16.0	0.76	20.6
3/4	19.0	1.09	29.4
7/8	22.0	1.49	39.8
1	26.0	1.94	51.7
1-1/8	29.0	2.46	65.0
1-1/4	32.0	3.03	79.9
1-3/8	35.0	3.67	96.0
1-1/2	38.0	4.37	114.0

Please note: The strengths listed in the table reflect only the 6x19 and 6x36 classes. BXL, or plastic-infusion, may be added to many products, excluding rope designs in which the rope itself is compacted. For additional information, please contact WW's customer service department.

Strands: 6
Wires per strand: 19 to 36
Core: IWRC
Standard grade(s):
Purple Plus
Lay: Regular or Lang
Finish: Plastic-infused



FLATTENED STRAND

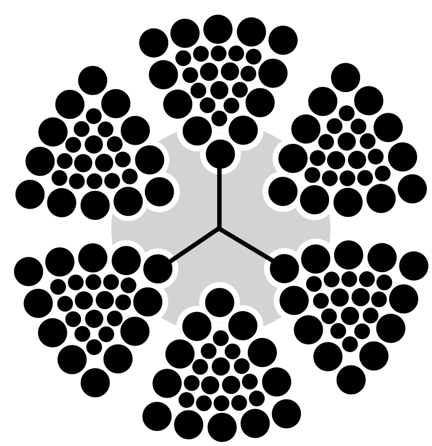
This rope is particularly suitable where severe conditions of crushing and abrasion are encountered on the drum or where a higher strength design factor is required than can be obtained with a similar round rope.

The triangular strand shape not only provides better resistance to crushing, but also offers a greater exposed surface area for contact with sheaves, drums or underlying layers of spooled rope. This feature, in connection with the use of Lang lay construction, distributes the abrasive wear over a greater number and length of wires.

The smooth surface of the rope also helps minimize wear on drums and sheaves.

Rope Diameter		Approx. Weight (lb./ft.)		Nominal Strength*, tons	
				Purple Plus	
inches	mm.	Fiber Core	IWRC	Fiber Core	IWRC
1-1/8	29.0	2.28	2.39	63.7	68.5
1-1/4	32.0	2.81	2.95	78.1	84
1-3/8	35.0	3.40	3.57	94.1	101
1-1/2	38.0	4.05	4.25	111	119
1-5/8	42.0	4.75	4.99	130	140
1-3/4	45.0	5.51	5.79	152	161
1-7/8	48.0	6.33	6.65	171	184
2	52.0	7.20	7.56	194	207
2-1/8	54.0	8.13	8.54	215	233
2-1/4	58.0	9.10	9.56	240	260

Strand: 6
Wires per strand: 27
Core: IWRC or fiber core
Standard Grade(s): Purple Plus
Lay: Lang
Finish: Bright



ROEPAC COMPACTED

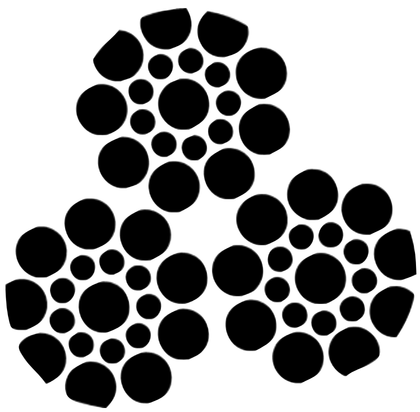
ROEPAC is a three strand compacted rope with high breaking strength and stable construction making it perfect as a pulling rope for overhead transmission lines and underground conduits. It's flexibility and flat surface provides snag-free guidance of the attached lines.

Abrasion Resistance. Compacted design provides improved abrasion resistance compared to standard 6 strand ropes because of the increased Wire and strand surfaces contacting the sheaves and drum.

Resistance to Drum Crushing. ROEPAC's compact design offers increased resistance to drum crushing.

Diameter (inches)	Standard Construction	Approx. Weight (lb/ft)	Minimum Breaking Strength (short tons)
3/8	3x19	.295	8.4
7/16	3x19/37	.409	11.4
1/2	3x19/37	.542	14.8
5/8	3x37	.767	21.7
3/4	3x37	1.123	31.1
7/8	3x43	1.568	42.1
1	3x43	2.067	54.7
1 1/8	3x43	2.561	68.9

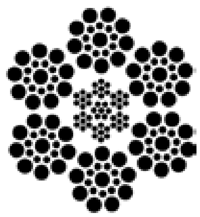
Strands: 3
Wires per strand: 19/37/43
Core: None
Lay: Right Regular
Finish: Bright



Oil Field & Natural Gas Drilling Products

6x19
Rotary Drilling Line

Features:
Excellent balance between fatigue and wear resistance

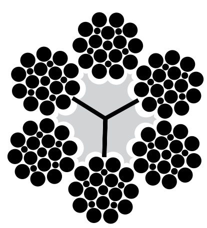


Rotary Drill Lines					
		Steel Core			
			EIP	EEIP	
Diameter (inches)	Standard Construction	Approx. Weight (lb/ft)	Minimum Breaking Strength (net tons)	Minimum Breaking Strength (net tons)	Diameter (inches)
1	6x19 S	1.85	51.7	56.9	1
1 1/8	6x19 S	2.34	65.0	71.5	1 1/8
1 1/4	6x19 S	2.89	79.9	87.9	1 1/4
1 3/8	6x19 S	3.50	96	106	1 3/8
1 1/2	6x19 S	4.16	114	125	1 1/2
1 5/8	6x19 S/6x26 WS	4.88	132	146	1 5/8
1 3/4	6x19 S/6x26 WS	5.67	153	169	1 3/4
1 7/8	6x26 WS	6.50	174	192	1 7/8
2	6x26 WS	7.39	198	217	2

*All drill lines have asphaltic lube, post lubed, and are RRL

6x21
Cable Tool Line

Features:
Increased resistance to bending fatigue on Cable Tool Rigs

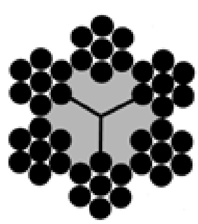


Cable Tool Lines				
		Fiber Core		
Diameter (inches)	Standard Construction	Approx. Weight (lb/ft)	Minimum Breaking Strength (net tons)	Diameter (inches)
5/8	6x21 Left Lay	0.66	14.5	5/8
3/4	6x21 Left Lay	0.95	20.7	3/4
7/8	6x21 Left Lay	1.29	28.0	7/8
1	6x21 Left Lay	1.68	36.4	1

*All cable lines have petrolatum lube, are LRL, and FC

6x7
Sand Lines & Swabbing Lines

Features:
High abrasion resistance

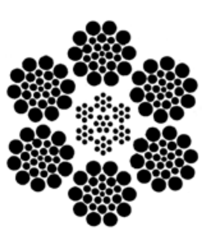


Sand Lines				
		Fiber Core		
Diameter (inches)	Standard Construction	Approx. Weight (lb/ft)	Minimum Breaking Strength (net tons)	Diameter (inches)
3/8	6x7	0.21	5.86	3/8
7/16	6x7	0.29	7.93	7/16
1/2	6x7	0.38	10.3	1/2
9/16	6x7	0.48	13.0	9/16
9/16	6x7 galv	0.47	13.0	9/16
5/8	6x7	0.59	15.9	5/8

*All sand lines have petrolatum lube and are RRL

6x26
Tubing Line

Features:
Excellent balance between fatigue and wear resistance



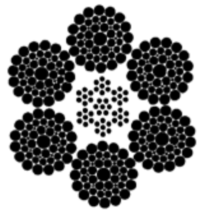
Tubing Lines				
		Steel Core		
Diameter (inches)	Standard Construction	Approx. Weight (lb/ft)	Minimum Breaking Strength (net tons)	Diameter (inches)
7/8	6x26 WS	1.42	39.8	7/8
1	6x26 WS	1.85	51.7	1
1 1/8	6x26 WS	2.34	65.0	1 1/8

*All sand lines have petrolatum lube and are RRL

Riser Tensioner Ropes

Features:

Special construction and multiple wire tensile increasing fatigue resistance



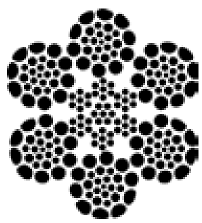
Riser Tensioner Ropes					
			Steel Core		
Diameter (inches)	(mm)	Standard Construction	Approx. Weight (lb/ft)	Minimum Breaking Strength (net tons)	Diameter (inches)
1 3/4	45	6x49	5.6	146	1 3/4
1 7/8	48	6x49	6.6	167	1 7/8
2	52	6x49	7.5	189	2
2 1/8	54	6x49	8.3	211	2 1/8
2 1/4	58	6x49	9.4	236	2 1/4
2 3/8	60	6x49	10.3	263	2 3/8
2 1/2	64	6x49	11.7	288	2 1/2
2 5/8	67	6x57	12.5	317	2 5/8
2 3/4	70	6x57	13.8	345	2 3/4

*All tensioners have asphaltic lube, and are RLL or LLL

Swaged Tubing Line

Features:

Compacted rope and higher breaking strength, excellent crush resistance and abrasion resistance



Swaged Tubing Lines				
		Steel Core		
Diameter (inches)	Standard Construction	Approx. Weight (lb/ft)	Minimum Breaking Strength (net tons)	Diameter (inches)
7/8	6x26 WS	1.80	47	7/8
7/8	6x31 WS	1.82	47	7/8
1	6x26 WS	2.35	62	1
1	6x31 WS	2.26	62	1

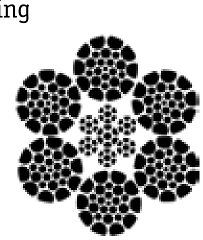
*All swaged tubing lines have petrolatum lube and are RRL or LRL

6-Pac

Features:

Compacted strand design provides improved service life and abrasion resistance

Increase flexibility to multilayer drum crushing



6-Pac			
			EEIP
Diameter (inches)	Standard Const.	Approx. Weight (lb/ft	Minimum Breaking Strength (net tons)
7/16	6x19 S	0.39	11.20
1/2	6x26	0.49	14.6
9/16	6x26	0.63	18.5
5/8	6x26	0.78	22.7
3/4	6x26	1.13	32.4
7/8	6x26	1.54	43.8
1	6x26	2.00	56.9
1 1/8	6x31	2.54	71.5
1 1/4	6x31	3.14	87.9
1 3/8	6x36	3.80	106
1 1/2	6x36	4.50	125
1 5/8	6x36	5.27	146
1 3/4	6x36	6.24	169
1 7/8	6x36	7.02	192

*All sand lines have petrolatum lube and are RRL

Galvanized Products

WW manufacturers most ropes with a galvanized coating on the individual wires. For rope specifics contact your Regional Sales Manager or Customer Service at 800-541-7673.

Anchor Lines

Rope and Strand anchor lines are designed to meet specific requirements.

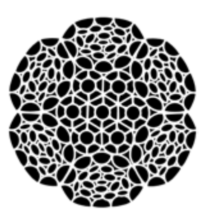
Super-Pac

Features:

Compacted strand and rope design provides superior abrasion resistance

Excellent resistance to effects of drum crushing

Increased strength capability



Super Pac			
			EEIP
Diameter (inches)	Const.	Approx. Weight (lb/ft)	Minimum Breaking Strength (net tons)
1/2	6x26	0.65	18
9/16	6x26	0.81	23
5/8	6x26	1.00	29
3/4	6x31	1.43	40
7/8	6x31	1.92	52
1	6x26	2.42	68
1 1/8	6x26	2.96	85
1 1/8	6x36	2.96	85
1 1/4	6x26	3.51	100
1 1/4	6x36	3.51	100
1 3/8	6x26	4.31	120
1 3/8	6x36	4.31	120

*All sand lines have petrolatum lube and are RRL

Handling & Installation

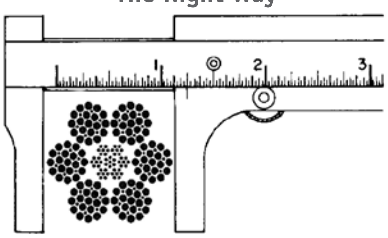
Handling

Measuring Rope Diameter

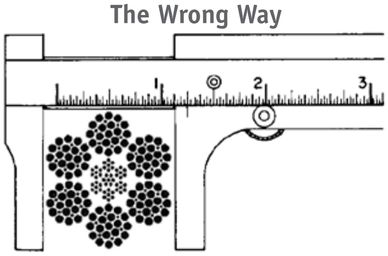
Rope diameter is specified by the user and is generally given in the equipment manufacturer's instruction manual accompanying the machine on which the rope is to be used.

Rope diameters are determined by measuring the circle that just touches the extreme outer limits of the strands — that is, the greatest dimension that can be measured with a pair of parallel-jawed calipers or machinist's caliper square. A mistake could be made by measuring the smaller dimension.

The Right Way



The Wrong Way



Unreeling & Uncoiling

The Right Way To Unreel. To unreel wire rope from a heavy reel, place a shaft through the center and jack up the reel far enough to clear the floor and revolve easily. One person holds the end of the rope and walks a straight line away from the reel, taking the wire rope off the top of the reel. A second person regulates the speed of the turning reel by holding a wood block against the flange as a brake, taking care to keep slack from developing on the reel, as this can easily cause a kink in the rope. Lightweight reels can be properly unreeled using a vertical shaft; the same care should be taken to keep the rope taut.

Correct

The Wrong Way To Unreel. If a reel of wire rope is laid on its flange with its axis vertical to the floor and the rope unreeled by throwing off the turns, spirals will occur and kinks are likely to form in the rope. Wire rope always should be handled in a way that neither twists nor unlays it. If handled in a careless manner, reverse bends and kinks can easily occur.

The Right Way To Uncoil. There is only one correct way to uncoil wire rope. One person must hold the end of the rope while a second person rolls the coil along the floor, backing away. The rope is allowed to uncoil naturally with the lay, without spiraling or twisting. Always uncoil wire rope as shown.

The Wrong Way To Uncoil. If a coil of wire rope is laid flat on the floor and uncoiled by pulling it straight off, spirals will occur and kinking is likely. Torsions are put into the rope by every loop that is pulled off, and the rope becomes twisted and unmanageable. Also, wire rope cannot be uncoiled like hemp rope. Pulling one end through the middle of the coil will only result in kinking.

Kinks

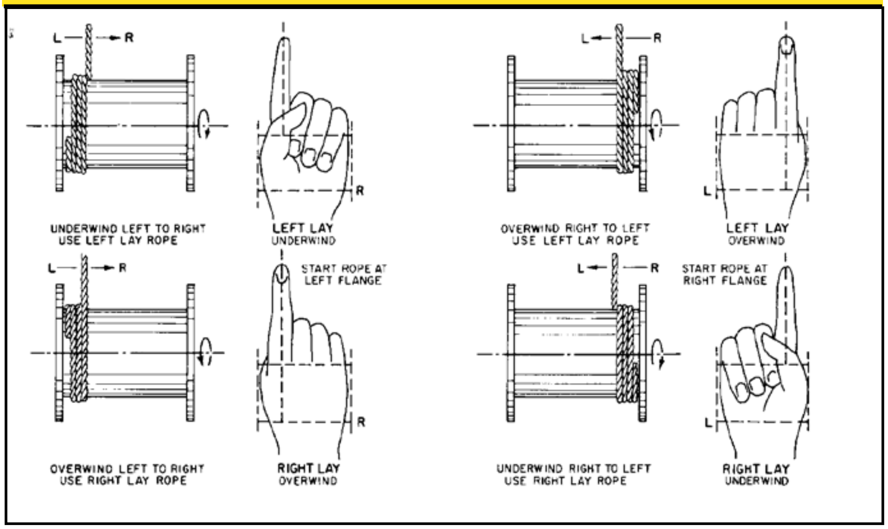
Great stress has been placed on the care that should be taken to avoid kinks in wire rope. Kinks are places where the rope has been unintentionally bent to a permanent set. This happens where loops are pulled through by tension on the rope until the diameter of the loop is only a few inches. They are also caused by bending a rope around a sheave having too severe a radius. Wires in the strands at the kink are **permanently damaged** and will not give normal service, even after apparent "restraightening."

Drum Winding

When wire rope is wound onto a sheave or drum, it should bend in the manner in which it was originally wound. This will avoid causing a reverse bend in the rope. Always wind wire rope from the **top of the one reel onto the top of the other.** Also acceptable, but less so, is re-reeling from the bottom of one reel to the bottom of another. Re-reeling may also be done with reels having their shafts vertical, but extreme care must be taken to ensure that the rope always remains taut. It should never be allowed to drop below the lower flange of the reel. A reel resting on the floor with its axis horizontal may also be rolled along the floor to unreel the rope.

Correct

By holding the right hand or left hand with the index finger extended, palm up or palm down, the proper procedure for applying left and right lay rope can easily be determined.



Wire rope should be attached at the correct location on a flat or smooth-faced drum, so that the rope will spool evenly, with the turns lying snugly against each other in even layers. If wire rope is wound on a smooth-face drum in the wrong direction, the turns in the first layer of rope will tend to spread apart on the drum. This results in the second layer of rope wedging between the open coils, crushing and flattening the rope as successive layers are spooled.

A simple method of determining how a wire rope should be started on a drum is shown above. The observer stands behind the drum, with the rope coming towards him. Using the right hand for right-lay wire rope, and the left hand for left lay wire rope, the clenched fist denotes the drum, the extended index finger the oncoming rope.

Wire Rope Clips

Clips are usually spaced about six wire rope diameters apart to give adequate holding power. They should be tightened before the rope is placed under tension. After the load is placed on the rope, tighten the clips again to take care of any lessening in rope diameter caused by tension of the load. A wire rope thimble should be used in the eye of the loop to prevent kinking.

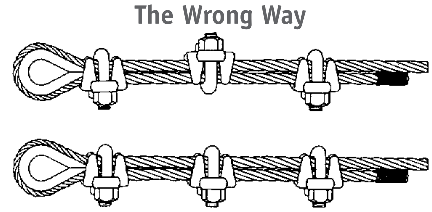
The correct number of clips for safe operation and the spacing distances are shown in the table.

U-bolt Clips. There is only one correct method for attaching U-bolt clips to wire rope ends, as shown in *The Right Way*. The base of the clip bears on the live end of the rope; the "U" of the bolt bears on the dead end.

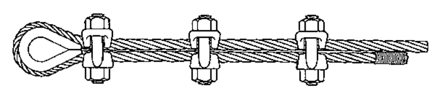
Compare this with the incorrect methods. Five of the six clips shown are incorrectly attached—only the center clip in the top view is correct. When the "U" of the clip bears on the live end of the rope, there is a possibility of the rope's being cut or kinked, with subsequent failure.

The Right Way

The Wrong Way



Twin-base Clips. Twin-base clips are installed as shown below. Due to their special design, they cannot be installed incorrectly.



Number of clips and spacing for safe application (center to center)

Rope Diam. (inches)	U-bolt					Twin-base				
	U-bolt Diam. (inches)	Approx. Weight (lb.)	Min. Number per Rope End	Spacing (inches)	Amount of Turn Back (inches)	Nut Size (inches)	Approx. Weight (lb.)	Min. Number per Rope End	Spacing (inches)	Amount of Turn Back (inches)
1/8	7/32	0.05	2	1-5/8	3-1/4					
3/16	1/4	0.08	2	2	3-3/4					
1/4	5/16	0.17	2	2-3/8	4-3/4	3/8	0.21	2	1-7/8	4
5/16	3/8	0.30	2	2-5/8	5-1/4	3/8	0.26	2	2-1/8	5
3/8	7/16	0.41	2	3-1/4	6-1/2	7/16	0.38	2	2-1/4	5-1/4
7/16	1/2	0.65	2	3-1/2	7	1/2	0.60	2	2-5/8	6-1/2
1/2	1/2	0.75	3	3-3/4	11-1/2	1/2	0.60	2	3	11
9/16	9/16	1.00	3	4	12	5/8	1.08	3	3-3/8	12-3/4
5/8	9/16	1.00	3	4	12	5/8	1.08	3	3-3/4	13-1/2
3/4	5/8	1.40	4	4-1/2	18	5/8	1.34	3	4-1/2	16
7/8	3/4	2.40	4	5-1/4	19	3/4	2.20	4	5-1/4	26
1	3/4	2.50	5	6	26	3/4	2.68	4	6	37
1-1/8	3/4	3.00	6	6-3/4	34	3/4	2.96	4	6-3/4	41
1-1/4	7/8	4.50	7	7-1/2	44	7/8	4.03	5	7-1/2	55
1-3/8	7/8	5.20	7	8-1/4	44	1	6.58	5	8-1/4	62
1-1/2	7/8	5.90	8	9	54	1	6.58	5	9	78
1-5/8	1	7.30	8	9-3/4	58					
1-3/4	1-1/8	9.80	8	10-1/2	61					
2	1-1/4	13.40	8	12	71					
2-1/4	1-1/4	15.70	8	13-1/2	73					
2-1/2	1-1/4	17.90	9	15	84					

Seizing Wire Rope

Proper seizing and cutting operations are not difficult to perform, and they ensure that the wire rope will meet the user's performance expectations. Proper seizings must be applied on both sides of the place where the cut is to be made. In a wire rope, carelessly or inadequately seized ends may become distorted and flattened, and the strands may loosen. Subsequently, when the rope is operated, there may be an uneven distribution of loads to the strands; a condition that will significantly shorten the life of the rope.

Either of the following seizing methods is acceptable. Method No. 1 is usually used on wire ropes over one inch in diameter. Method No. 2 applies to ropes one inch and under.

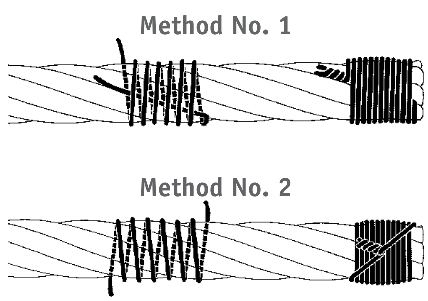
Method No. 1: Place one end of the seizing wire in the valley between two strands. Then turn its long end at right angles to the rope and closely and tightly wind the wire back over itself and the rope until the proper length of seizing has been applied. Twist the two ends of the wire together, and by alternately pulling and twisting, draw the seizing tight.

Method No. 2: Twist the two ends of the seizing wire together, alternately twisting and pulling until the proper tightness is achieved.

The Seizing Wire. The seizing wire should be soft or annealed wire or strand. Seizing wire diameter and the length of the seize will depend on the diameter of the wire rope. The length of the seizing should never be less than the diameter of the rope being seized.

Proper end seizing while cutting and installing, particularly on rotation-resistant ropes, is critical. Failure to adhere to simple precautionary measures may cause core slippage and loose strands, resulting in serious rope damage. Refer to the table for established guidelines. If core protrusion occurs beyond the outer strands, or core retraction within the outer strands, cut the rope flush to allow for proper seizing of both the core and outer strands.

In the absence of proper seizing wire or tools, the use of sufficiently-sized hose clamps is acceptable.



Installation

The majority of wire rope problems occurring during operation actually begin during installation, when the rope is at its greatest risk of being damaged. Proper installation procedures are vital in the protection and performance of wire rope products.

Provide Proper Storage

Until the rope is installed it should be stored on a rack, pallet or reel stand in a dry, well-ventilated storage shed or building. Tightly sealed and unheated structures should be avoided as condensation between rope strands may occur and cause corrosion problems. If site conditions demand outside storage, cover the rope with waterproof material and place the reel or coil on a support platform to keep it from coming directly in contact with the ground.

While lubrication is applied during the manufacturing process, the wire rope must still be protected by additional lubrication once it is installed. Lubricants will dry out over a period of time and corrosion from the elements will occur unless measures are taken to prevent this from happening. When the machine becomes idle for a period of time, apply a protective coating of lubricant to the wire rope. Moisture (dew, rain, and snow) trapped between

Suggested End Preparations

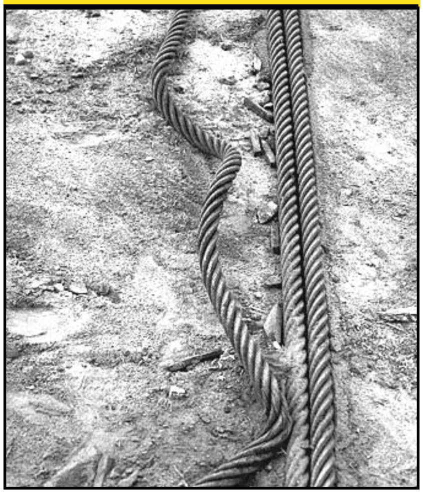
Rope Design	End Preparation
all standard preformed wire rope 6x26 reverse lay 6-PAC & 6-PAC RV	single seizing
all standard non-preformed wire rope 8x19 Class rotation-resistant TRIPLE-PAC	double seizing; fuse welding optional
SFP 19 rotation-resistant SFP 35 rotation-resistant	double seizing and fuse welding required

Suggested Seizing Wire Diameters

Rope Diameters		Suggested Seizing Wire Diameters	
inches	mm.	inches	mm.
1/8" to 5/16"	3.2 to 8.0	.032	0.813
3/8" to 9/16"	9.5 to 14.5	.048	1.21
5/8" to 15/16"	16.0 to 24.0	.063	1.60
1" to 1-1/16"	26.0 to 33.0	.080	2.03
1-1/8" to 1-11/16"	35.0 to 43.0	.104	2.64
1-3/4" and larger	45.0 and larger	.124	3.15

Length of seizing should not be less than rope diameter.

Rope Kinked During Installation



strands and wires will create corrosion if the rope is unprotected. Also apply lubricant to each layer of wire rope on a drum because moisture trapped between layers will increase the likelihood of corrosion.

Check The Rope Diameter Prior To Installation

Always use the nominal diameter as specified by the equipment manufacturer. Using a smaller diameter rope will cause increased stresses on the rope and the probability of a critical failure is increased if the rated breaking strength does not match that of the specified diameter. Using a larger diameter rope leads to shorter service life as the rope is pinched in the sheave and drum grooves which were originally designed for a smaller diameter rope. Just as using a different diameter rope can create performance problems, so can the use of an excessively undersized or oversized rope.

Measure the wire rope using a parallel-jawed caliper as discussed in Measuring Rope Diameter. If the rope is the wrong size or outside the recommended tolerance, return the rope to the wire rope supplier. It is never recommended nor permitted by federal standards to operate cranes with the incorrect rope diameter. Doing so will affect the safety factor or reduce service life and damage the sheaves and drum. Note that in a grooved drum application, the pitch of the groove may be designed for the rope's nominal diameter and not the actual diameter as permitted by federal standards.

Use Proper Unreeling Procedures

Wire rope can be permanently damaged by improper unreeling or uncoiling practices. **The majority of wire rope performance problems start here.** Improper unreeling practices lead to premature rope replacement, hoisting problems and rope failure.

Place the payout reel as far away from the boom tip as is practical, moving away from the crane chassis. Never place the payout reel closer to the crane chassis than the boom point sheave. Doing so may introduce a reverse bend into the rope and cause spooling problems. Follow the guidelines highlighted under Unreeling & Uncoiling and Drum Winding. Take care to determine whether the wire rope will wind over or under the drum before proceeding. If the wire rope supplier secured the end of the rope to the reel by driving a nail through the strands, ask that in the future a U-bolt or other nondestructive tie-down method be used; nails used in this manner damage the rope.

Take extra precaution when installing Lang lay, rotation-resistant, flattened strand or compacted ropes. Loss of twist must be avoided to prevent the strands from becoming loosened, causing looped wire problems.

Keep Wraps Tight

The end of the rope must be securely and evenly attached to the drum anchorage point by the method recommended by the equipment manufacturer. Depending on the crane's regulatory requirements, at least two to three wraps must remain on the drum as dead wraps when the rope is unwound during normal operations. Locate the dead end rope anchorage point on the drum in relation to the direction of the lay of the rope as shown in *Drum Winding*. Do not use an anchorage point that does not correspond with the rope lay. Mismatching rope lay and anchorage point will cause the wraps to spread apart from each other and allow the rope to cross over on the drum. Very gappy winding will occur resulting in crushing damage in multilayer applications.

Back tension must be continually applied to the payout reel and the crewman installing the rope must proceed at a slow and steady pace **whether the drum is smooth or grooved.** Regardless of the benefits of a grooved drum, tension must be applied to ensure proper spooling. An improperly installed rope on a grooved drum will wear just as quickly as an improperly installed rope on a smooth drum. If a wire rope is poorly wound and as a result jumps the grooves, it will be crushed and cut under operating load conditions where it crosses the grooves.

Every wrap on the first or foundation layer must be installed very tightly and be without gaps. Careless winding results in poor spooling and will eventually lead to short service life. The following layers of rope must lay in the grooves formed between adjacent turns of the preceding layer of rope. If any type of overwind or crosswinding occurs at this stage of installation and is not corrected immediately, poor spooling and crushing damage will occur.

Poor Spooling

On a multilayer spooling drum be sure that the last layer remains at least two rope diameters below the drum flange top. Do not use a longer length than is required because the excess wire rope will cause unnecessary crushing and may jump the flange. Loose wraps that occur at any time must be corrected immediately to prevent catastrophic rope failure.

The use of a mallet is acceptable to ensure tight wraps, however a steel-faced mallet should be covered with plastic or rubber to prevent damage to the rope wires and strands.

Treat Rotation-Resistant Ropes With Extra Care

Rotation-resistant ropes of all constructions require extra care in handling to prevent rope damage during installation. The lay length of a rotation-resistant rope must not be disturbed during the various stages of installation. By introducing twist or torque into the rope, core slippage may occur—the outer strands become shorter in length, the core slips and protrudes from the rope. In this condition the outer strands become overloaded because the core is no longer taking its designed share of the load. Conversely, when torque is removed from a rotation-resistant rope core slippage can also occur. The outer strands become longer and the inner layers or core become overloaded, reducing service life and causing rope failure.

Secure The Ends Before Cutting

The plain end of a wire rope must be properly secured. If the entire cross section of the rope is not firmly secured, core slippage may occur, causing the core to pull inside the rope's end and allowing it to protrude elsewhere, either through the outer strands (popped core) or out the other end of the line. The outer layer of the outside strands may also become overloaded as there is no complete core-to-strand support.

Secure the ends of the rope with either seizing or welding methods as recommended under Seizing. It is imperative that the ends be held together tightly and uniformly throughout the entire installation procedure, including attaching the end through the wedge socket and the drum dead end wedge.

Use a Cable Snake

When installing a new line, connect the old line to the new line by using a swivel-equipped cable snake or Chinese finger securely attached to the rope ends. The connection between the ropes during change-out must be very strong and **prevent torque from the old rope being transferred into the new rope.** Welding ropes together or using a cable snake without the benefit of a swivel increases the likelihood of introducing torque into the new rope. A swivel-equipped cable snake is not as easy as welding the ropes, but this procedure can be mastered with a little patience and practice.

Standard Operating Practices

Perform A Break-in Procedure

Perform a break-in procedure to achieve maximum service life. Run the new rope through its operating cycle several times under a light load at a reduced line speed. A light load is normally considered to be 10% of the working load limit. This allows the rope to adjust gradually to working conditions, enables the strands to become settled, and allows for slight stretching and diameter reduction to occur.

Maintain Equipment

Wire rope performance depends upon the condition of the equipment on which it operates. Poorly maintained equipment may result in reduced service life.

Avoid Slack In The Rope

In any hoisting operation, there should be no slack in the wire rope when the load is applied. Otherwise the resulting stress will be excessive. As discussed previously, shockload- ing is destructive and results in irreparable damage to the rope.

Slowly Lift Or Release The Load

Overstressing the rope is a result of too-rapid acceleration or deceleration. Wire rope will withstand considerable stress if the load is applied slowly.

Use a Wire Rope Only On The Job For Which It Was Intended

Sometimes an idle rope from one operation is installed on another to keep the rope in continuous service. This extremely poor practice is an expensive economy. Because wire rope tends to set to the conditions of its particular job, the differing bends, abrasions and stresses of a new operation may produce premature failure. Therefore, for maximum life and efficiency, a rope should be used only on a job for which it has been specified.

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

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

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

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

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

Allowable Wire Breaks

ASME No.	Equipment	No. Broken Wires In Running Ropes In		No. Broken Wires in Standing Ropes In	
		one rope lay	one strand	one rope lay	one strand
B30.2	Overhead and gantry crane	12*	4	n/a	n/a
B30.4	Portal, tower and pillar cranes	6*	3	3*	2
B30.5	Crawler, locomotive and truck cranes	6*	3	3*	2
B30.6	Derricks	6*	3	3*	2
B30.7	Base-mounted drum hoists	6*	3	3*	2
B30.8	Floating cranes and derricks	6*	3	3*	2
A10.4	Personnel hoists	6*	3	2*	2
A10.5	Material hoists	6*	n/a	n/a	n/a

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

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

Basic Guidelines

Abrasion

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

Corrosion

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

Wire Breaks

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

Recommended Retirement Criteria Based On Diameter Reduction

Original Diameter (inches)	Loss Of Diameter (inches)		
5/16" and smaller	1/64"	or	.016"
3/8" through 1/2"	1/32"	or	.031"
9/16" through 3/4"	3/64"	or	.049"
7/8" through 1-1/8"	1/16"	or	.063"
1-1/4" through 1-1/2"	3/32"	or	.094"
1-3/4" through 2-1/8"	1/8"	or	.125"
2-1/4" through 2-5/8"	5/32"	or	.156"

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

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

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

Diameter Reduction

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

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

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

Crushing

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

Shockloading

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

High Stranding

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

Inspection Guidelines For Specialty Rope

Plastic-infused Rope

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

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

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

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

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

Compacted Rope

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

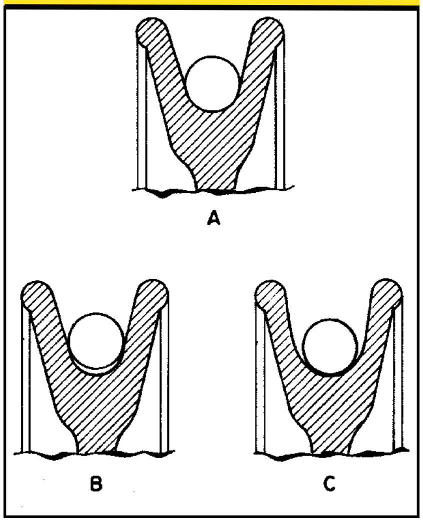
In the inspection of compacted rope designs, again it is imperative to follow the basic inspection guidelines and use both visual and actual measuring techniques to determine the remaining life of the rope. In fact, actual measuring techniques are very important when inspecting these ropes. While corrosion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

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

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

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

Representations of three wire rope seating conditions: [A] new rope in new groove; [B] new rope in worn groove; [C] worn rope in worn groove.



Drums & Sheaves

Drums

Inspect the flanges for wear, chips, cracks and bending. Inspect the Lebus grooving (if so equipped), visor and kicker plates for wear. Also look for rope imprinting damage.

Sheaves

Examine the sheave grooves for wear and proper diameter. To check the size, contour and amount of wear, use a sheave gage. The gage should contact the groove for about 150° of arc.

Inspect the fleet angle for poor sheave alignment. The fleet angle is the side, or included, angle between a line drawn through the middle of a sheave and a drum, perpendicular to the axis of each, and a line drawn from the intersection of the drum and its flange to the base of the groove in the sheave. The intersection of the drum and its flange represents the farthest position to which the rope can travel across the drum. There are left and right angles, measured to the left or right of the center line of the sheave, respectively. It is important to maintain a proper fleet angle on installations where wire rope passes over a lead sheave and onto a drum. A fleet angle larger than recommended limits can result in excessive rubbing of the rope against the flanges of the sheave groove, or crushing and abrasion of the rope on the drum. This angle, for maximum efficiency and service, should not be more than 1-1/2 degrees for a smooth drum, nor more than 2 degrees if the drum is grooved. The minimum angle which ensures that the rope will cross back and start a second layer in a normal manner, without mechanical assistance, should be 0 degrees 30 minutes. For smooth faced drums, this works out to a distance of 38 feet for each foot (76 feet for two feet) of side travel from the center line of the sheaves to the flange of the drum. For a grooved drum, the distance is 29 feet.

Other conditions which may exist include:

Corrugated sheaves. Easily noticed, corrugated sheaves should be machined or preferably replaced.

Worn sheaves. If sheaves are wearing to one side, move the sheave to correct the fleet angle and alignment.

Broken flanges. Broken sheave flanges enable wire rope to jump the sheave and become badly cut or sheared. Replace the sheaves.

Out-of-round sheaves. A sheave with a flat spot throws a "whip" into the rope at every sheave revolution. This may cause wire fatigue at the attachment end where vibration due to the whipping is usually dampened or stopped. Machine or replace the sheave.

Synthetic sheaves

When using synthetic sheaves or synthetic-lined steel sheaves, the inspector must carefully examine the rope for diameter reduction or lengthening of lay, even if no visible damage is observed. Synthetic sheaves greatly increase the contact area between the wire rope and sheave, by cushioning the rope. This cushioning effect causes wire rope to wear internally (wire rope operating on steel sheaves will first wear externally) before the damage is noted on the outer wires. This situation places the inspector at a great disadvantage; therefore, he/she must be diligent in the detection of diameter reduction and lay lengthening to prevent catastrophic failure from internal core damage.

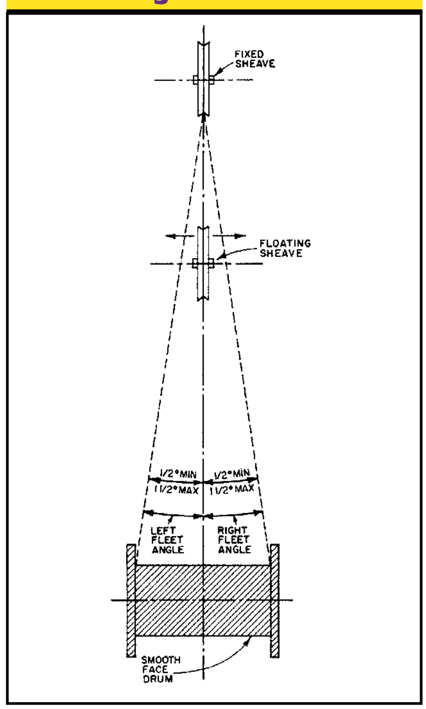
Bearings

Check the bearings for lubrication, signs of wobble and ease of rotation. Worn bearings cause vibration in the rope, increasing wire fatigue. Repair the bearings or replace the sheave.

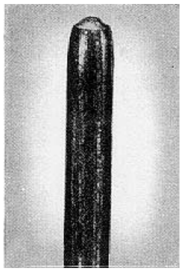
Rollers and Fairleads

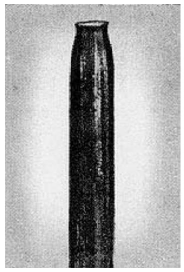
Inspect rollers and fairleads for ease of rotation and worn grooves, which may cut the wires. These rollers should be covered with either rubber or a polymer material to further prevent rope abrasion damage.

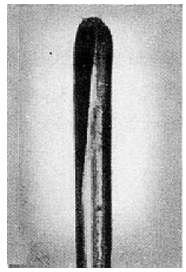
Fleet Angle



Typical Characteristics and Causes of Broken Wires in Wire Rope

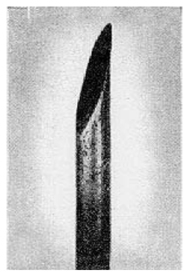

Tension (cone)


Tension (cup)


Tension & wear

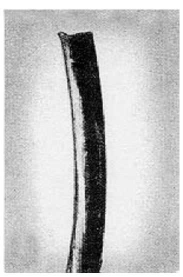
Tension Breaks

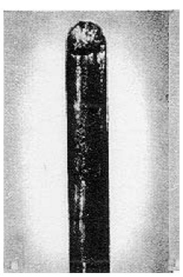
Wire break shows one end of broken wire coned, the other cupped. Necking down of the broken ends is typical of this type of break. Where tension breaks are found, the rope has been subjected to overloading, either for its original strength (new rope) or for its remaining strength in the case of a used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

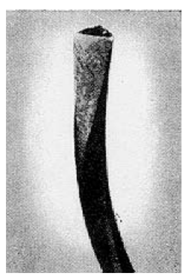

Abrasion

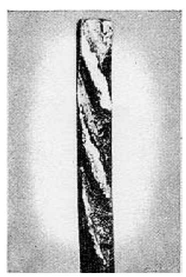
Abrasion Breaks

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


Fatigue (square type)

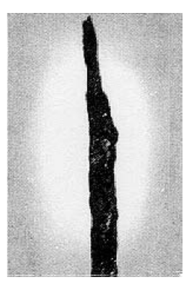

Fatigue (jagged type)


Fatigue & Wear


Fatigue & Nicking

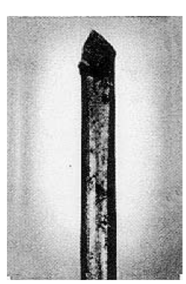
Fatigue Breaks

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


Corrosion

Corrosion Breaks

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


Cut or Shear

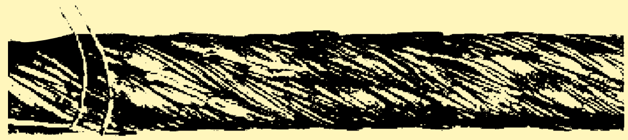
Cut or Shear

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

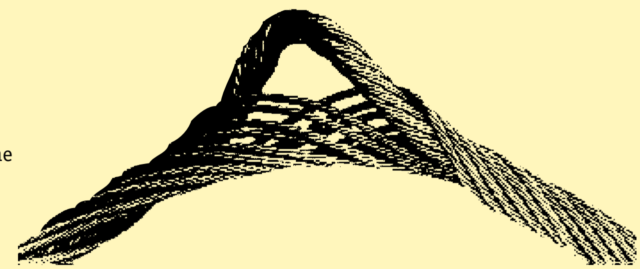
Troubleshooting Checklist

ABRASION	Frozen sheaves or rollers Tight grooves Excessive fleet angle Oversized or undersized rope Corrugated sheave or drum Sheave overspin Rope jumping the sheave Poor spooling Misaligned sheaves Site contaminants
CORE PROTRUSION/SLIPPAGE	Shockloading Poor seizing techniques Poor installation techniques
CORROSION	Lack of lubrication Environmental damage, e.g. acidic fume exposure Improper storage
CRUSHING	Poor installation techniques Crosswinding Poor spooling Incorrect wire rope construction Poor break-in procedure Excessive fleet angle Excessive rope length
DIAMETER REDUCTION	Lack of lubrication (fiber core) Excessive abrasion Corrosion, internal and/or external Inner wire or core failure
FATIGUE	Out of round sheaves Tight grooves Misaligned sheaves Undersized sheaves Worn bearings Vibration Slapping Whipping Reverse bends
HIGH STRANDING	Poor seizing techniques Tight grooves Undersized sheaves Poor installation techniques
JUMPING THE SHEAVE	Poor spooling Excessive rope length Broken flange
KINKING	Poor unreeling procedures Poor installation techniques Undersized sheaves
LAY LENGTHENING/TIGHTENING	Poor installation techniques Poor unreeling procedures Corrosion Core failure
LOOPED WIRES	Poor installation techniques Undersized sheaves
UNBALANCED ROPE	Oversized sheaves

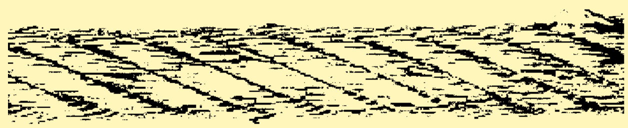
Abrasion



Core Protrusion (Shockloading)

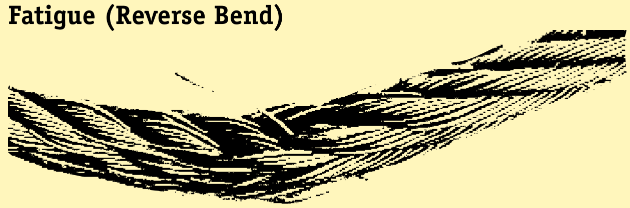


Corrosion

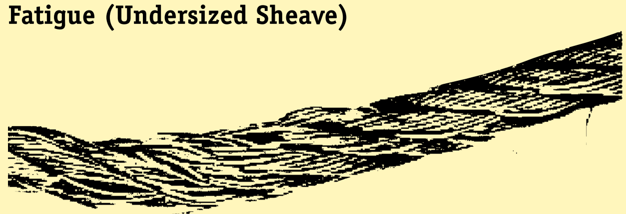


Crushing

Fatigue (Reverse Bend)



Fatigue (Undersized Sheave)



WW Specifications

WW manufactures Bethlehem Wire Rope to Federal Specification RR-W-410-E, and to meet requirements of the American Bureau of Shipping, Lloyd's Registry, American Petroleum Institute, and others that may be applicable.

Some special purpose ropes are covered by other specifications. Mining ropes follow the recommended specifications of the U.S. Bureau of Mines. Elevator ropes, to meet conditions peculiar to operation of passenger and freight elevators, are generally made to other, more restrictive specifications.

Specifications serve a useful purpose in establishing certain manufacturing limitations and practices. However, they do not specify that wire rope meet a certain quality standard. Rather, specifications and certifications indicate the permissible minimum. Bethlehem Wire Rope products are manufactured with many quality features and manufacturing practices not defined in specifications.

WW Markers

Wire rope manufactured in the United States normally has some type of colored marker to identify the manufacturer. Two types of markers may be used—strand markers and core markers.

A strand marker can be seen by looking at the wire rope; it is simply a colored lubricant applied externally to one strand during manufacture. Strand markers are not used in mining rope, elevator rope, galvanized rope, compacted rope or any rope that is post-lubricated. Strand markers are used in the manufacture of all standard (round) wire ropes but are not a confirmation of the manufacturer in an of itself.

Core markers are used in most wire rope manufactured in the United States, but cannot be seen unless the wire rope is disassembled. Manufacturers add colored threads of filaments to fiber and steel cores.

Every Bethlehem Wire Rope product contains one or both types of markers. WW uses a purple strand in the manufacture of all standard EIP and EEIP Bethlehem Wire Rope, excluding those ropes cited previously. In addition, every Bethlehem Wire Rope product contains two filaments in the core (either fiber or steel)—one yellow and one purple filament.

Wire Rope Tolerances

Wire rope is always manufactured larger—never smaller—than the nominal diameter when specified in inches. The allowable tolerances are shown in the table.

In standard practice, the nominal diameter is the minimum diameter. All tolerances are taken on the plus side when specified in inches. Wire rope is not termed oversize until its diameter exceeds the allowable maximum. For example, a 1" nominal diameter wire rope may vary between 1" and 1.05" in diameter.

Rope Strength Design Factors

The rope strength design factor is the ratio of the rated strength of the rope to its operating stress. If a particular rope has a rated strength of 100,000 lbs. and is working under an operating stress of 20,000 lbs., it has a rope strength design factor of 5. It is operating at one-fifth or 20% of its rated strength.

Many codes refer to this factor as the "safety factor" which is a misleading term since this ratio obviously does not include many facets of an operation which must be considered in determining safety.

Wire rope is an expendable item —a replacement part of a machine or installation. For economic and other reasons, some installations require ropes to operate at high stresses (low rope strength design factors). On some installations where high risk is involved, high rope strength design factors must be maintained. However, operating and safety codes exist for most applications and these codes give specific factors for usage. When a machine is working and large dynamic loadings (shockloadings) are imparted to the rope, the rope strength design factor will be reduced, which may result in over stressing of the rope.

Diameter Tolerances

Nominal Diameter (inches)	Under	Over*
Through 1/8"	-0	+8%
Over 1/8" - 3/16", incl.	-0	+7%
Over 3/16" - 5/16", incl.	-0	+6%
Over 3/8"	-0	+5%

*These tolerances appear in Federal Standard RR-W-410-E.

Constructional Stretch

Rope Construction	Approximate Stretch*
6-strand fiber core	1/2% to 3/4%
6-strand IWRC	1/4% to 1/2%
8-strand fiber core	3/4% to 1%
8-strand IWRC	1/2% to 3/4%

*Varies with magnitude of the loading

Reduced rope strength design factors frequently result in reduced service life of wire rope.

Physical Properties

The following discussion relates to conventional 6- or 8-strand ropes that have either a fiber or steel core. It is not applicable to rotation-resistant ropes since these constitute a separate case.

Wire rope is an elastic member; it stretches and elongates under load. This stretch is derived from two sources:

Constructional stretch. When a load is applied to wire rope, the helically-laid wires and strands act in a restricting manner, thereby compressing the core and bringing all of the rope elements into closer contact. The result is a slight reduction in diameter and an accompanying lengthening of the rope. Constructional stretch is influenced by:

- Type of core
- Rope construction
- Length of lay
- Material

Ropes with a WSC or IWRC have less constructional stretch than those with a fiber core. The reason for this is steel cannot compress as much as the fiber core. Usually, constructional stretch will increase at an early stage in the rope's life. However, some fiber core ropes, if lightly loaded (as in the case of elevator ropes), may display a degree of constructional stretch over a considerable portion of their lives. A definite value for determining constructional stretch cannot be assigned since it is influenced by several factors. The Constructional Stretch table on the previous page gives some idea of the approximate stretch as a percentage of rope under load.

Elastic stretch. Elastic stretch results from recoverable deformation of the metal itself. Here again, a quantity cannot be precisely calculated. However, the equation shown below can provide a reasonable approximation for many situations.

In actuality, there may be a third source of stretch—a result of the rope's rotating on its own axis. Such elongation, which may occur either as a result of using a swivel, or from the effect of a free turning load, is brought about by the unlaying of rope strands. This type of stretch is undesirable and may lead to rope failure.

Elastic Stretch

$$\text{Changes in length (ft.)} = \frac{\text{Change in load (lbs.)} \times \text{Length (ft.)}}{\text{Area (inches}^2\text{)} \times \text{Modulus of Elasticity (psi)}}$$

Recommended Sheave Diameters

Construction	Suggested D/d Ratios	Minimum D/d Ratios
6x7	72	42
19x7 rotation-resistant	51	34
6x19 Seale	51	34
Flattened Strand	45	30
6x25 Filler Wire 6x31 Warrington Seale 6-PAC	39	26
6x36 Warrington Seale	35	23
TRIPLE-PAC	35	23
8x19 Seale	41	27
8x25 Filler Wire	32	21
SFP 19 36DD	31	20

D = tread diameter of the sheave
d = nominal diameter of the rope

Effect of Sheave Size

Wire ropes are manufactured in a great variety of constructions to meet the varying demands of wire rope usage. Where abrasion is an important factor, the rope must be made of a coarse construction containing relatively large outer wires. In other cases, the great amount of bending to which the rope is subjected is more important. Here, a more flexible construction, containing many relatively small wires, is required. In either case, however, if the rope operates over inadequate size sheaves, the severe bending stresses imposed will cause the wires to break from fatigue, even though actual wear is slight. The smaller the diameter of the sheave, the sooner these fatigue breaks will occur and the shorter rope life becomes.

Another undesirable effect of small sheaves is accelerated wear of both rope and sheave groove. The pressure per unit area of rope on sheave groove for a given load is inversely proportional to the size of the sheave. In other words, the smaller the sheave the greater the rope pressure per unit area on the groove. Both sheaves and rope life can obviously be prolonged by using the proper diameter sheave for the size and construction of rope.

Sheave diameter can also influence rope strength. When a wire rope is bent around a sheave, there is a loss of effective strength due to the inability of the individual strands and wires to adjust themselves entirely to their changed position. Tests show that rope strength efficiency decreases to a marked degree as the sheave diameter is reduced with respect to the diameter of the rope.

A definite relationship exists between rope service and sheave size. As a guide to users, wire rope manufacturers have established standards for sheave sizes to be used with various rope constructions.

Block Twisting

Block twisting or cabling is one of the most frequently encountered wire rope problems in the construction industry. When this problem occurs, the wire rope is most often blamed, and other equally important factors in the operation are overlooked.

Personnel experienced with handling wire rope know that conventional wire ropes will twist or unlay slightly when a load is applied. In a reeved hoisting system subjected to loading and unloading, such as a hoist line, this results in block twisting and possibly distortion of the wire rope. Cabling of the block most frequently occurs as the load in the wire rope is released and the falls are in a lowered position. Cabling may be considered as the twisting of the block beyond one-half revolution (180° twisting) of the traveling block. When this condition occurs, the operator shows good judgement in not making additional lifts until the conditions causing the problem are corrected.

The following machine and site conditions should be investigated for possible improvement in block twisting.

1. **Reduce wire rope length.** Longer rope lengths cause more twisting than short rope lengths. This applies particularly to the amount of wire rope in the fall.
2. **Reduce the amount of load lifted.** Heavily loaded ropes have more torque and twist than lightly loaded ropes. This condition would also apply to the speed of loading or shockloading, since this condition also causes higher wire rope loading.
3. **Eliminate odd-part reeving** where the wire rope dead end is on the traveling block. Wire rope torque, from the application of load, is greatest at the rope dead end.
4. **Relocate the rope dead end at the boom** in order to increase the separation between the dead end and the other rope parts. This applies a stabilizing load directly to the traveling block. The original equipment manufacturer should be consulted before making this modification.
5. **Increase sheave size.** This increases the amount of separation between wire rope parts and may improve the situation by applying stabilizing loads and reducing the amount of rope torque transmitted to the traveling block.
6. **Restrain the twisting block with a tag line.**
   The use of rotation-resistant wire ropes will not likely be required unless the intended length of rope fall exceeds 100 feet, or the length of the hoist line exceeds 600 feet. In the event these latter conditions exist, the end user should anticipate using a combination of the rotation-resistant wire rope and the foregoing field suggestions.

Wire Rope Slings

Basic Hitches

Each lift uses one of three basic hitches.

Straight/vertical. Vertical slings connect a lifting hook to a load. Full rated lifting capacity of the sling may be used. To prevent load rotation, use a tagline.

Two or more slings may be used to create a lifting bridle. Attach slings to the same lifting hook or spreader beam and different points on the load. The load is then distributed equally among the individual slings.

Choker. A choker hitch may be used when the object or load will not be damaged by the sling body, nor the sling damaged by the load. Pull the choker hitch tight before the lift is made. It is dangerous to allow the action of the lift to pull the choker hitch down. Use more than one choker sling to lift a load that might slide or shift out of the choke.

Choker hitches reduce sling rated capacities for lifting. When a choke is drawn down tight against a load, or a side pull is exerted resulting in an angle of choke less than 120°, an adjustment must be made for further reduction of the sling rated capacity. As the angle of choke decreases, there is a corresponding loss of sling efficiency. Refer to the table to determine the rated capacity adjustment for choker hitches.

Basket Hitch. A basket hitch will distribute the weight of a load more equally between the two legs. The rated sling lifting capacity is affected where the sling body comes in contact with the load. As the angle between the legs of the sling increases, the load on each leg increases.

Effect Of Angles On Sling Capacities

The rated capacity of a multiple leg sling is directly affected by the angle of the sling leg with the vertical. As this angle increases, the stress on each leg increases with the load, as shown below. If the sling angle is known, the capacity can be readily determined by multiplying the sling's vertical capacity by the appropriate load angle factor.

D/d Ratios

Rated capacities of a sling can also be affected by the ratio of the diameter if the object around which the sling is bent to the diameter of the rope used in the sling. This is known as the D/d ratio where D is the diameter of the object and d is the diameter of the rope. As the D/d ratio becomes smaller, the loss of strength becomes greater and the rope becomes less efficient.

Sling Eye Designs

Sling eyes are affected by the same general forces which apply to legs of a sling rigged as a basket. Never use a sling eye over a hook or pin that has a body diameter larger than the natural width of the eye. Never force an eye onto a hook. The eye should always be used on a hook or pin with at least the nominal diameter of the rope.

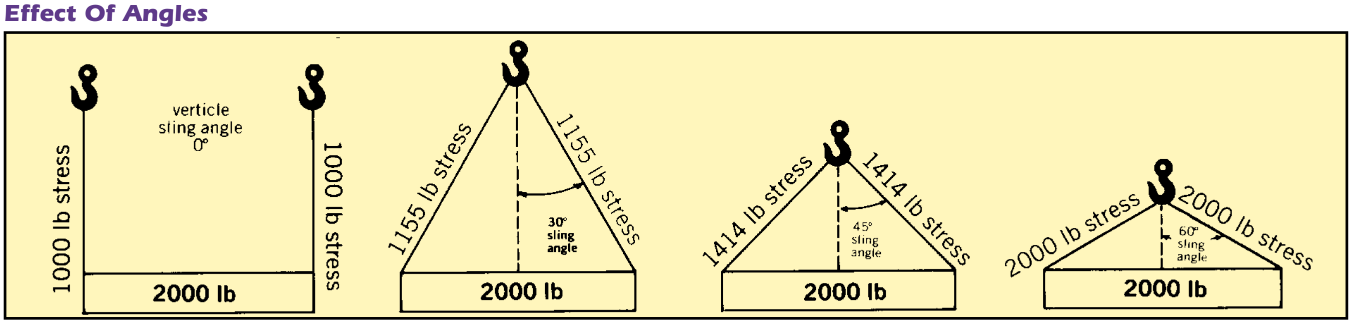
Load Angle Factors

SLING ANGLE	RATED CAPACITY MULTIPLIER
0° (vertical)	1.00
15°	0.97
30°	0.87
45°	0.71
60°	0.50
75°	0.26

Choker Hitch Rated Capacity Adjustment

ANGLE OF CHOKE	RATED CAPACITY IWRC and FC
90° to less than 120°	87%
60° to less than 90°	74%
30° to less than 60°	62%
0° to less than 30°	49%

Effect Of Angles



Wire Rope Sling Inspection

An exact determination of when to retire a sling depends on many variables, and limited federal guidelines exist. Rather sling retirement (and safety factors) must be left to the judgement of a trained and experienced professional who is capable of evaluating remaining strength in the sling. Proper allowance must be made for deterioration as disclosed by inspection. The safety of an operating sling depends upon this remaining strength.

The following conditions must be taken into account when determining the safe operating condition of a sling.

1. For strand laid and single part slings, ten randomly distributed wires on one rope lay, or five broken wires in one strand in one rope lay.
2. For cable laid and braided slings of less than eight parts, twenty randomly distributed broken wires in one lay or braid, or one broken strand per sling
3. For braided slings of eight parts or more, forty randomly distributed wires in one lay or two broken strands per sling
4. Severe localized abrasion or scraping.
5. Kinking, crushing, bird caging or any other damage resulting in distortion of the wire rope.
6. Evidence of heat damage: if a wire rope sling having a fiber core is exposed to temperatures in excess of 200° F; or if a wire rope sling having an IWRC is used at temperatures above 400° F or below -60° F.
7. End attachments that are cracked, deformed or worn.
8. Hooks that have been opened more than 15% of the normal throat opening measured at the narrowest point more than 10° from the plane of the unbent hook.
9. Corrosion of the rope or end attachments.

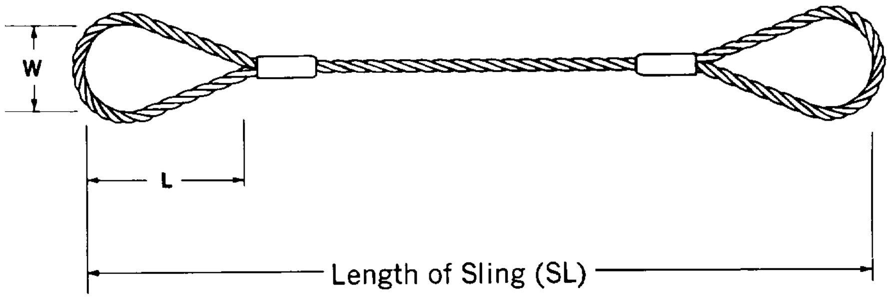
Recommended Operating Practices

Whenever any sling is used, the following practices must be observed.

1. Destroy retired slings.
2. Never expose slings to temperatures in excess of the manufacturer's recommendations.
3. Use a sling that is long enough to provide the minimum practical vertical angle.
4. Never shorten a sling with knots, bolts or other methods.
5. Never twist or kink the legs of a sling.
6. Never load a sling in excess of its rated capacity.
7. Center the load in the base (bowl) of the hook to prevent point loading.
8. When using a basket hitch, balance the load to prevent slippage.
9. Always protect slings from sharp edges.
10. Securely hitch each sling to its load.
11. Avoid shockloading.
12. Never pull a sling from under a load while that load is resting on the sling.
13. Never use homemade fittings and attachments.
14. Never make a sling from used wire rope.
15. Never use any sling that is of questionable strength and condition.

No. 105-B With Torpedo Loop-lock Splices

Single-leg sling with standard Flemish eye mechanical splice, secured with steel sleeves.



DIAM. INCHES	MIN LENGTH (SL) OF SLING (feet-inches)	LOOP DIMENSIONS		RATED CAPACITIES IN TONS (2,000 lbs.) PURPLE PLUS (EIP) IWRC				
		W (in)	L (in)	CHOKER	VERTICAL	BASKET HITCH (degrees to vertical)		
						60°	45°	30°
1/4	1-6	2	4	0.48	0.65	0.65	0.91	1.10
3/8	2	3	6	1.10	1.40	1.40	2.00	2.50
1/2	2-6	4	8	1.90	2.50	2.50	3.60	4.40
5/8	3	5	10	2.90	3.90	3.90	5.50	6.80
3/4	3-6	6	12	4.10	5.60	5.60	7.90	9.70
7/8	4	7	14	5.60	7.60	7.60	11.00	13.00
1	4-6	8	16	7.20	9.80	9.80	14.00	17.00
1-1/8	5	9	18	9.10	12.00	12.00	17.00	21.00
1-1/4	5-6	10	20	11.00	15.00	15.00	21.00	26.00
1-3/8	6	11	22	13.00	18.00	18.00	25.00	31.00
1-1/2	7	12	24	16.00	21.00	21.00	30.00	37.00
1-3/4	8	14	28	21.00	28.00	28.00	40.00	49.00
2	9	16	32	28.00	37.00	37.00	52.00	63.00

Rated capacities of basket hitches are based on a minimum diameter of curvature at the point of load contact of 40 times the rope diameter for slings 1/4" through 1" diameter, and 25 times the rope diameter for slings 1-1/8" diameter and larger.

Construction and Industrial Applications

- Standard 6x19 and 6x36 classes
- Standard rotation-resistant ropes in 8x19, 8x25, 19x7 constructions
- Specialized rotation-resistant ropes SFP-19
- 6-PAC and 6-PAC RV
- Triple-Pac EEEIP crane rope
- BXL plastic-infused wire rope
- Roepac compacted wire rope
- Alternate lay wire rope

Oil Field Applications

- Rotary drill lines
- Tubing lines
- Sand lines
- Well measuring line
- Well servicing line
- 6x25 flex seale tubing line
- 6-Pac tubing line
- Flattened strand rope

Elevator Applications

- 6x19, 8x19, and 9x19 classes for hoist, governor and compensating rope applications

Logging Applications

- Standard 6x19 and 6x36 Classes
- Super-B
- Super-PAC
- 6-PAC
- BXL
- SKYBRITE

Mining Applications

- Standard 6x19, 6x36, 6x61, 6x70, 8x19 and 8x37 Classes
- Boom pendants
- Flattened strand rope
- En-Core plastic encapsulated core for drag ropes
- Bethpac compacted wire rope
- Maxi-Core IWRC
- BXL plastic-infused rope
- Phoenix specially-designed hoist ropes

Ocean Cable Systems

- Anchor/mooring systems
- Galvanized torque-balanced spiral strand, bare or sheathed, with or without Z-nodes
- Galvanized wire rope, with or without Z-nodes

WW manufactures a complete line of Bethlehem Wire Rope up to 7" diameter and structural strand products up to 6" diameter, as well as various wire products. Contact WW's customer service department for further information on these and other products.

Bethlehem Wire Rope Service Centers

California:	Compton
Illinois:	Chicago
Indiana:	Boonville
Oklahoma:	Oklahoma City
Oklahoma:	Woodward
Missouri:	St. Louis
Pennsylvania:	Williamsport
Texas:	Houston
Texas:	Odessa
Washington:	Seattle

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