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

The following information is NOT a complete discussion of wire rope or wire rope slings. WHAT FOLLOWS IS A BRIEF OUTLINE OF THE BASIC INFORMATION REQUIRED TO SAFELY USE WIRE ROPE AND WIRE ROPE SLINGS.

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

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

3. The NOMINAL STRENGTH, sometimes called CATALOG strength, of a wire rope applies ONLY to a NEW, UNUSED rope.

4. The Nominal Strength of a wire rope SHOULD BE CONSIDERED the straight line pull which will ACTUALLY BREAK a new, UNUSED rope. The Nominal Strength of a wire rope should NEVER BE USED AS ITS WORKING LOAD.

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

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

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

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

6. WIRE ROPES WEAR OUT. The strength of a wire rope begins to decrease when the rope is put in use, and continues to decrease with each use.

7. NEVER OVERLOAD A WIRE ROPE. This means NEVER USE the rope where the load applied to it is greater than the working load determined by dividing the Nominal Strength of the rope by the appropriate Design Factor.

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

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

10. Regular, periodic INSPECTIONS of the wire rope, and keeping of PERMANENT RECORDS SIGNED BY A QUALIFIED PERSON, are REQUIRED BY OSHA FOR ALMOST EVERY WIRE ROPE INSTALLATION. The purpose of inspection is to determine whether or not a wire rope or wire rope sling may continue to be safely used on that application. Inspection criteria, including number and location of broken wires, wear and elongation, have been established by OSHA, ANSI, ASME and similar organizations. IF IN DOUBT, REPLACE THE ROPE.

An inspection should include verification that none of the specified removal criteria for this usage are met by checking for such things as:

- Surface wear: Normal and unusual.
- Broken wires: Number and location.
- Reduction in diameter.
- Rope stretch (elongation).
- Integrity of end attachments.
- Evidence of abuse or contact with another object.
- Heat damage.
- Corrosion.

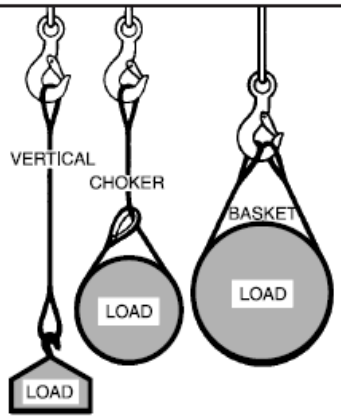
In addition, an inspection should include the condition of sheaves, drums and other apparatus with which the rope makes contact.

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

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

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

- Sheaves that are too small, worn or corrugated cause damage to a wire rope.
- Broken wires mean a loss of strength.
- Kinks permanently damage a wire rope and must be avoided.
- Wire ropes are damaged by knots, and wire ropes with knots must never be used.
- Environmental factors such as corrosive conditions and heat can damage a wire rope.
- Lack of lubrication can significantly shorten the useful service life of a wire rope.
- Contact with electrical wires and the resulting arcing will damage a wire rope.



Every Lift Uses 1 of 3 Basic Hitches

VERTICAL, or straight, attachment is simply using a sling to connect a lifting hook or other device to a load. Full rated load of the sling may be used, but never exceeded. A tagline should be used on such a lift to prevent rotation which can damage the sling. A sling with a hand-tucked splice can unlay and fail if the sling is allowed to rotate.

CHOKER hitches reduce lifting capability of a sling, since this method of rigging affects the ability of the wire rope components to adjust during the lift, places angular loading on the body of the sling, and creates a small diameter bend in the sling body at the choke point.

BASKET hitches distribute a load equally between the two legs of a sling, within limitations imposed by the angles at which legs are rigged to the load. (See discussion of sling angles below.)

Basic Factors Concerning Use of Wire Rope Slings

1. RATED LOAD (Rated Capacity) of a wire rope sling is based upon the Nominal, or Catalog, Strength of the wire rope used in the sling, AND FACTORS which affect the overall strength of the sling. These factors include ATTACHMENT or SPLICING EFFICIENCY, the number of parts of rope in the sling, type of hitch (e.g., straight pull, choker hitch, basket hitch), DIAMETER AROUND WHICH THE BODY OF THE SLING IS BENT, and the diameter of pin (or hook) over which the eye of the sling is rigged.

2. RATED LOAD of a sling is different for each of the three basic methods of rigging (See graphic above.). These rated loads are available from your wire rope sling supplier and may be indicated on the tag attached to the sling at the time it is fabricated (if requested by the user).

3. WARNING: A hand-tucked eye splice can unlay (unravel) and fail if the sling is allowed to rotate during use.

4. NEVER “SHOCK LOAD” A SLING. There is no practical way to estimate the actual force applied by shock loading. The rated load of a wire rope sling can easily be exceeded by a sudden application of force, and damage can occur to the sling. The sudden release of a load can also damage a sling.

5. The BODY of a wire rope sling should be PROTECTED with corner protectors, blocking or padding against damage by sharp edges or corners of a load being lifted. Sharp bends that distort the sling body damage the wire rope and reduce its strength.

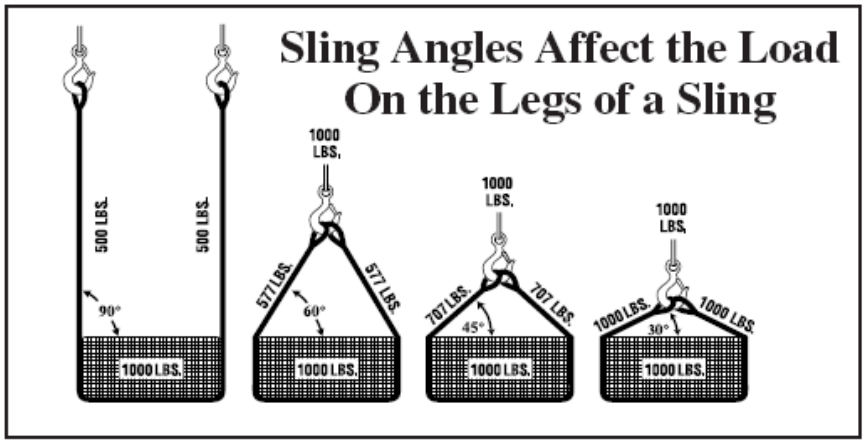
6. ANY ANGLE other than vertical at which a sling is rigged increases the loading on the sling.

7. A sling should be given a VISUAL INSPECTION BEFORE EACH LIFT OR USAGE to determine if it is capable of safely making the intended lift.
An inspection should include looking for such things as:

- Broken wires.
- Kinks or distortions of the sling body.
- Condition of eyes and splices, and any attached hardware.
- Reduction in diameter of the rope.
- Any damage.
- Corrosion.

8. Whenever a sling is found to be deficient, the eyes must be cut, or other end attachments or fittings removed to prevent further use, and the sling body discarded.

9. A SLING EYE should never be used over a hook or pin with 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 DIAMETER OF THE ROPE.



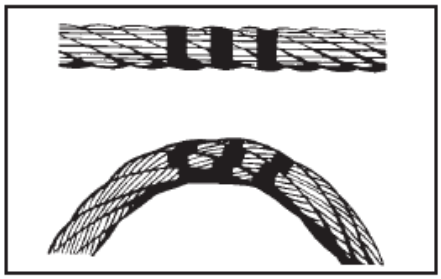
SLING ANGLE (also called Angle of Loading) is the angle measured between a horizontal line and the sling leg or body. This angle is very important and can have a dramatic effect on the rated load of the sling. As illustrated here, when this angle DECREASES, the LOAD ON EACH LEG INCREASES. This principle applies whether one sling is used with legs at an angle in a basket hitch, or for multi-leg bridle slings. Horizontal sling angles of LESS THAN 30 DEGREES SHALL NOT BE USED.

A Wire Rope Is a "Machine" With Many Moving Parts

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

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

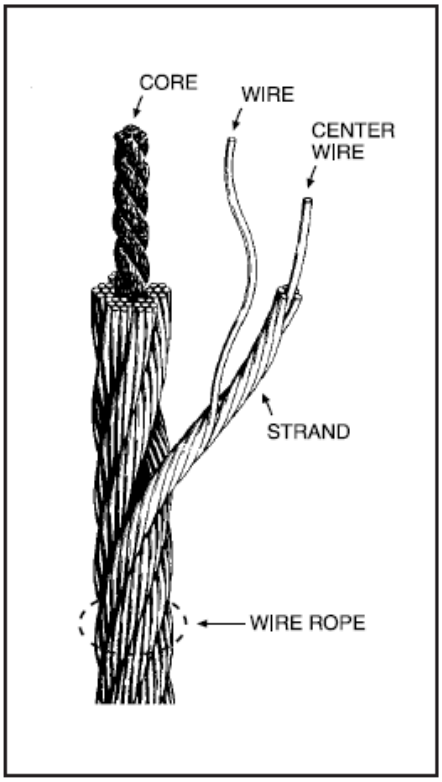
Every wire rope has three basic components: (1) The wires which form the strands and collectively provide rope strength; (2) The strands, which are laid helically around the core; and, (3) The core, which forms a foundation for the strands. The core may be either a fiber rope, an Independent Wire Rope Core (IWRC), which is actually a smaller wire rope, or a strand similar to the outer strands of the rope; only an IWRC or strand core contributes strength to the rope; and an IWRC normally provides only 7 1/2% of the wire rope's Nominal Strength.



The greatest differences in wire ropes are found in the strands, which may vary widely in the pattern and number of wires which are laid together.

The wires of a rope may be made of various metals, including steel, iron, stainless steel, monel, and bronze. The material of which the wires are made is the primary determinant of rope strength. By far the most widely used metal is high-carbon steel.

Carbon steel wire ropes come in various Grades. The term "Grade" is used to designate the Nominal Strength of the wire rope. The most common rope Grades are Traction Steel (TS), Plow Steel (PS), Improved Plow Steel (IPS), Extra Improved Plow Steel (EIPS), and Extra Extra Improved Plow Steel (EEIPS).



One cannot determine the Grade of a wire rope by its feel or appearance. To properly evaluate a rope system you must obtain the Grade from your employer or wire rope supplier.

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TABLE RC 1-11
MECHANICAL SPLICE
IWRC

VERTICAL, CHOKER OR VERTICAL BASKET

RATED CAPACITY IN TONS OF 2,000 lbs.
RATED CAPACITIES SHOWN APPLY ONLY TO 6X19 AND 6X36 CLASSIFICATION WIRE ROPE

ROPE DIAMETER (INCHES)	VERTICAL			CHOKER			VERTICAL BASKET		
	IPS	EIPS	EEIPS	IPS	EIPS	EEIPS	IPS	EIPS	EEIPS
1/4	0.56	0.65	0.71	0.41	0.48	0.52	1.1	1.3	1.4
5/16	0.87	1.0	1.1	0.64	0.74	0.81	1.7	2.0	2.2
3/8	1.2	1.4	1.6	0.92	1.1	1.2	2.5	2.9	3.2
7/16	1.7	1.9	2.1	1.2	1.4	1.6	3.4	3.9	4.3
1/2	2.2	2.5	2.8	1.6	1.9	2.0	4.4	5.1	5.5
9/16	2.8	3.2	3.5	2.0	2.4	2.6	5.5	6.4	7.0
5/8	3.4	3.9	4.3	2.5	2.9	3.2	6.8	7.8	8.6
3/4	4.9	5.6	6.2	3.6	4.1	4.5	9.7	11	12
7/8	6.6	7.6	8.3	4.8	5.6	6.1	13	15	17
1	8.5	9.8	11	6.3	7.2	8.0	17	20	22
1 1/8	10	12		7.9	9.1		21	24	
1 1/4	13	15		10	11		26	30	
1 3/8	15	18		12	13		31	36	
1 1/2	18	21		14	16		37	42	
1 5/8	21	24		16	18		43	49	
1 3/4	25	28		19	21		49	57	
1 7/8	28	32		21	24		56	64	
2	32	37		24	28		64	73	
2 1/8	35	40		27	31		69	80	
2 1/4	39	44		30	35		77	89	
2 3/8	43	49		33	38		86	99	
2 1/2	47	54		37	42		94	109	
2 5/8	52	60		40	46		104	119	
2 3/4	57	65		44	51		113	130	
2 7/8	61	71		48	55		123	141	
3	67	77		52	60		133	153	
3 1/8	72	82		56	64		144	165	
3 1/4	77	89		60	69		154	177	
3 3/8	83	95		64	74		165	190	
3 1/2	88	102		69	79		177	203	

RATED CAPACITIES BASKET HITCH BASED ON D/d RATIO OF 25
RATED CAPACITIES BASED ON PIN DIAMETER NO LARGER THAN NATURAL EYE WIDTH OR LESS THAN THE NOMINAL SLING DIAMETER
RATED CAPACITIES BASED ON DESIGN FACTOR OF 5
HORIZONTAL SLING ANGLES LESS THAN 30 DEGREES SHALL NOT BE USED

General Discussion

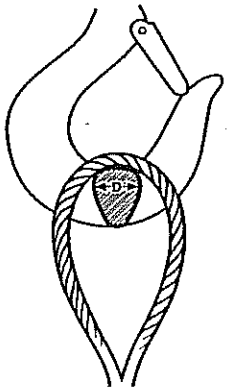

Figure 1

The purpose of this manual is to define wire rope slings in keeping with good practice and sound engineering design. Many areas of design apply to all types of slings. Specific design criteria will be covered in the appropriate sections. Rated Capacities shown in this manual are for wire rope slings fabricated from new wire rope.

DESIGN FACTOR is a number which is divided into the nominal strength of a sling to arrive at a rated capacity. A design factor is necessary to allow for conditions such as wear, abrasion, damage and variations in load which are not readily apparent. Design factors have been established which allow the sling to give the most efficient service to the user. Rated capacity tables contained in this manual are based on a design factor of five (5). Other design factors may be applied for engineered lifts; however, the sling manufacturer should always be consulted.

Sling Rated Capacity is based upon the minimum breaking force, formerly called nominal (catalog) strength, of the wire rope used in the sling and other factors which affect the overall strength of the sling. These other factors include splicing efficiency, number of parts of rope in the sling, type of hitch (e.g., straight pull, choker hitch, basket hitch, etc.), diameter around which the body of the sling is bent (D/d) and the diameter of pin used in the eye of the sling (Figure 1).

SLING ANGLE is the angle measured between a horizontal plane and the sling leg or body. This angle is very important and can have a dramatic effect on the rated capacity of the sling (2A). As illustrated (Figure 2B), when this angle decreases, the load on each leg increases. This principle applies whether one sling is used to pull at an angle, in a basket hitch or for multilegged bridle slings. Sling angles of less than 30 degrees shall not be used.

SLING ANGLES

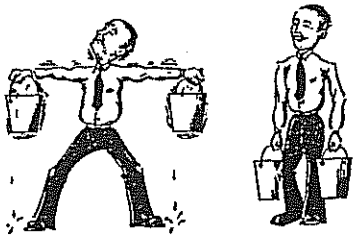

Figure 2A. How do you carry two buckets of water? The above illustrations typify the stresses imposed on slings when the legs are attached to the load at various angles.

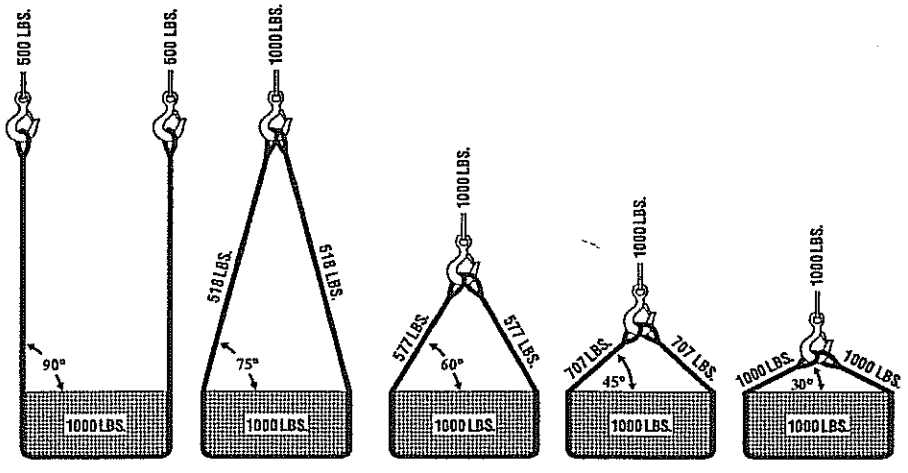

Figure 2B

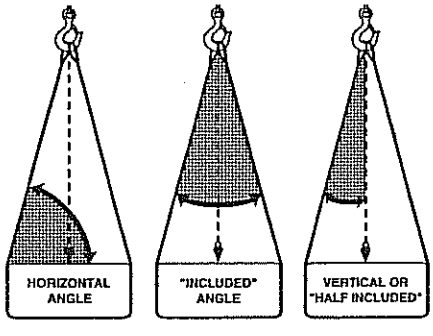

Figure 2C

SLING ANGLES in this manual are measured from the horizontal plane. If the horizontal angle is used you must use the trigonometric sine of the horizontal angle. When the vertical angle is used you must use the trigonometric cosine of the vertical angle (Figure 2C).

When to deduct weight of crane's hoist rope.

1. When manufacturer specifies in the load chart that the hoist rope be deducted.
2. When crane is reeved with more than the minimum parts of line required to lift the load.
3. When crane is rigged with hoist line not being used to make the lift.
4. When there are parts of line below ground level.

Rope Diameter Inches	Approximate Weight Pounds Per Foot (IWRC)
3/8	.26
7/16	.35
1/2	.47
9/16	.60
5/8	.73
3/4	1.06
7/8	1.44
1	1.88