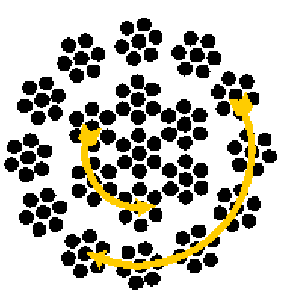
Rotation-resistant Wire Rope

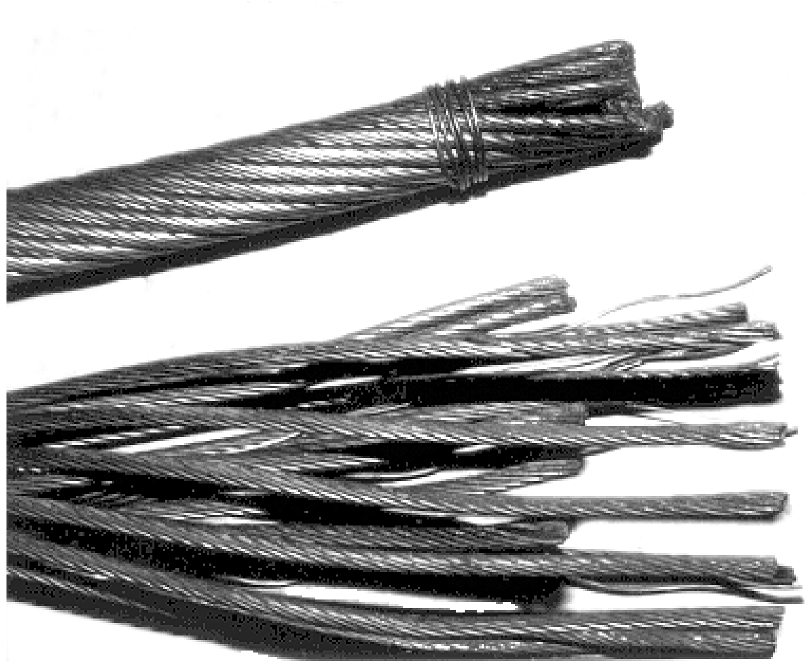
Handling & Operating Requirements

Rotation-resistant wire ropes are specially designed to re-sist spin or rotation while under load. Due to their design, they have certain restrictions on their application and special handling requirements that are unnecessary with other constructions.

The rotation-resistant characteristics are attained by a design of two or more layers of strands having differing (right **and** left) directions of lay, as shown below. Under load, one layer's directional rotation is counteracted by the tendency of the other layer(s) to rotate in the opposite direction. To impart greater resistance to rotation, these ropes are designed with a greater number of smaller diameter strands (when compared with the design of 6-strand constructions). The combination of smaller diameter strands and differing rope lays makes for a very delicate balance which can easily be "unbalanced" at anytime. **Die drawn rotation-resistant ropes (SFP 19 and 36DD) are especially susceptible to unbalancing,** as discussed later. Extra care must be taken when handling, installing and operating rotation-resistant wire ropes. **They cannot and should not be treated in the same manner as 6-strand constructions.**



This 19x7 cross section illustrates the different lay directions used in the manufacturing process of rotation-resistant rope. Due to the design, proper handling and installation are critical to the performance of all rotation-resistant wire ropes.



This photograph is a classic example of the effects of improper seizing. The seizing, inappropriate for even single seizing, has caused the core to slip. Notice the position of the core after the seizing is removed.

Seizing

Many people believe the purpose of securing the ends prior to cutting is to prevent the outer strands from flying. In the case of non-preformed 6x19 and 6x37 Classifications, this assumption is correct. However, this is not the case for rotation-resistant ropes.

The purpose of seizing a rotation-resistant rope is to maintain its balance by preventing movement of the individual strands and lay lengths. As mentioned earlier, die drawn rotation-resistant ropes are very sensitive. Die drawing enhances the strands' ability to rotate against themselves, eliminating the normal ratchet effect of non-die drawn designs. **It is therefore imperative that rotation-resistant ropes, particularly those of a die drawn design, are properly and tightly seized.**

Prior to cutting, tightly **double seize on each side where the cut is to be made**. The length of the each seizing should be, at a minimum, equal to the rope's diameter, with each seizing spaced six (6) rope diameters apart. Secure the ends by using soft or annealed wire for seizing. **The use of electrical or duct tape for seizing the ends is unacceptable.** Tape cannot provide the holding power needed to restrain the outer and inner strands. Wirerope Works, Inc. (WW) also strongly recommends fusing the ends of some rotation-resistant ropes after double seizing and cutting, as shown in Table 1.

Table 1: Seizing Requirements

Rope Design	Type of Seizing	Fuse Welding
8x19 Class Rotation-resistant 19x7 Rotation-resistant SFP 19 Rotation-resistant	Mandatory Double Seizing	Strongly Recommended
36DD Rotation-resistant 35x7 Rotation-resistant		Mandatory

Handling

Because of their sensitive nature, rotation-resistant wire ropes require careful handling prior to, during, and after installation if an acceptable service life is to be obtained. **The individual layer lay lengths must not be disturbed at any time.**

If turns are introduced into the rope, core slippage may occur -- the outer strands become shorter in length, and the inner strands slip and protrude from the rope. Under normal operating conditions, the outer strands become overloaded as the inner strands no longer assume their proper share of the load.

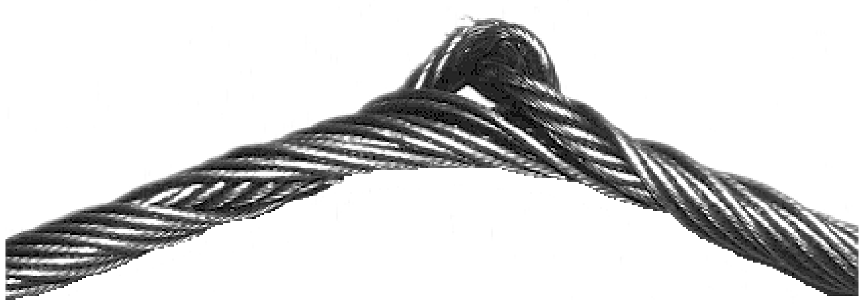
Core slippage may also occur if turns are removed from the rope. In this scenario, the outer strands become longer and birdcage, and the inner layers become shortened and overloaded. When the load is suddenly released, the inner strands protrude through the birdcaged outer strands and the rope must be retired.

Many problems with rotation-resistant ropes have their origins in the winding procedure. Improper winding procedures lead to premature rope replacement, hoisting problems and failure. **Always wind from the top of the payout reel to the top of the drum, or conversely, from bottom to bottom.** Winding from top to bottom, or vice versa, will introduce a reverse bend, and possibly torque, into the rope. Constant tension must be maintained to prevent rope looseness, core protrusion or birdcaging. Also ensure the anchorage point corresponds with the rope lay.

The multistrand design of rotation-resistant wire ropes make them very susceptible to crushing damage. Gappy winding will result in crushing damage in multilayer applications. **The foundation, and all subsequent layers, must be installed tightly and without gaps.** If any type of crosswinding or overwind occurs at this stage in installation and is not corrected immediately, crushing damage will occur.

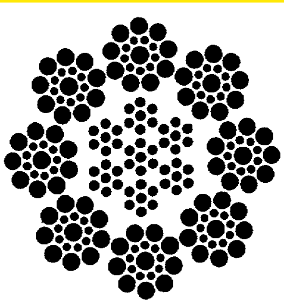
After the rope has been properly installed, **WW strongly recommends a break-in procedure.** Run the new wire rope through the complete operating cycle several times at a reduced speed and under a light (10%) load, thus allowing the wires and strands to adjust gradually to working conditions. This additional time will increase service life.

Swivels. The use of a swivel during installation will prevent torque in the old rope from being transferred to the new rope. **Never weld the two ropes together for the purpose of installation.** In some applications, swivels are also used to relieve accumulated rope twist during operation. Lock the swivel after the twist is relieved to prevent uncontrolled rotation. The use of an open swivel, or a swivel that is free

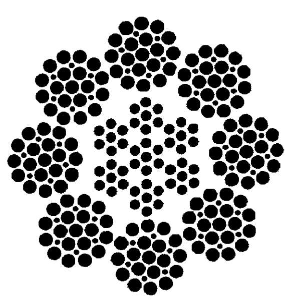


Improper installation procedures removed turns from this rope, loosening the outer strands and enabling the inner strands to protrude once the load was released.

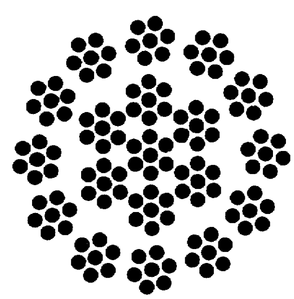
8x19 Seale IWRC



8x25 Filler Wire IWRC



19x7



to rotate continuously during the rope's operation, is **not recommended by WW for use with 8x19 Class, 19x7 and SFP 19 rotation-resistant ropes. An open swivel may be used with 36DD**, however.

Wedge Sockets. Because of the small radius over which wire rope is bent when a wedge socket is installed, and the probability of severe strand movement, extreme care must be exercised. To prevent core slippage or loss of rope lay, the dead end must be double seized and/or welded before the wire rope is inserted into the wedge socket. **The dead end tail length must be a minimum of twenty (20) times the rope's diameter, but not less than six inches.** Secure the dead end, but never attach the dead end to the live end.

Table 2: D/d Ratio Requirements

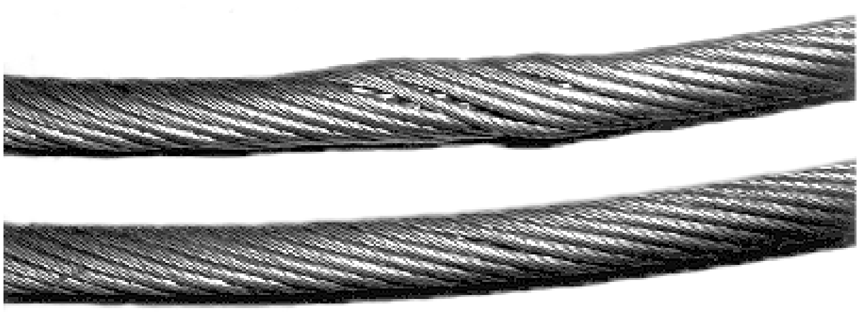
Construction	Suggested D/d Ratio	Minimum D/d Ratio
19x7	51	34
8x19 Seale	41	27
8x25 filler wire	32	21
SFP19 35x7 36DD	31	20

Operation

The proper operation of a rotation-resistant rope depends upon maintaining its torsional balance. Rotation-resistant ropes, with their small outer wires, multilayer strand design and differing rope lays are highly sensitive to operating conditions. When these design characteristics are combined with operating conditions that place great stress on the rope, the likelihood of birdcaging, high stranding, core protrusion, and ultimately rope failure, is greatly enhanced. These ropes are designed to provide resistance to rotation, not resistance to severe operating conditions. Assuming the rope was properly handled prior to its being operational, poor service life is normally caused by one or more of the following poor operating conditions.

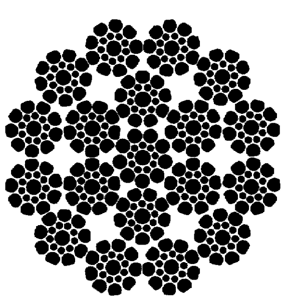
Crushing. Crushing may occur for a number of reasons -- excessive fleet angle, poor sheave alignment, poor spooling, etc. Any of the aforementioned conditions will cause more damage to a rotation-resistant rope than a rope manufactured in a 6-strand construction.

Incorrect Design Factors. The design factor is defined as the ratio of the nominal strength of the wire rope to the total load it is expected to lift. A common design factor is 5:1. This means that the rope's breaking strength should, at a minimum, exceed the operating stress, or load, by five (5) times. For example, if the load to be carried is 20,000 lbs., the breaking strength must be at least 100,000 lbs. Maintaining the proper design factor is imperative to the safe operation of rotation-resistant ropes. If proper design factors are not employed, users run the risk of operating a rope which loses its rotation-resistant properties and may become unbalanced. To expect any rotation-resistant characteristics, **a minimum**

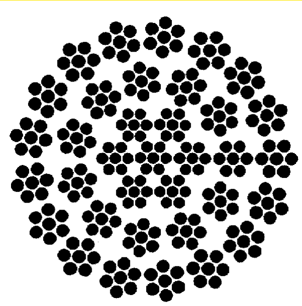


Drum crushing is one of the leading causes of early rope retirement. When installing a new rope, the foundation and all subsequent layers must be installed tightly and without gaps.

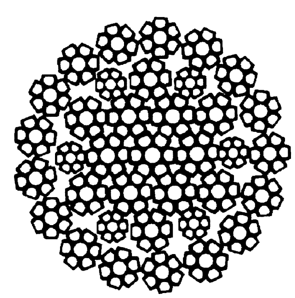
SFP 19 (19x19)



35x7



36DD (36x7)



5:1 strength to design factor must be maintained. With 8x19 class and 19x7 constructions, a minimum factor of 8:1 is advisable.

Improper D/d Ratios. The relationship between sheave diameter and rope diameter is a critical factor that is used to establish fatigue resistance or relative service life. This relationship is expressed as the D/d ratio, where *D* equals the tread diameter of the sheave, and *d* equals the diameter of the rope. Both sheave and drum D/d ratios and groove size have definite effects on:

- ultimate working strength
- fatigue characteristics
- bending stresses
- torque values
- looseness, balance and service life of wire rope

This is especially true for rotation-resistant designs. A proper D/d ratio must be maintained when rotation-resistant ropes are in operation. Many times high stranding will occur as a result of reduced D/d ratios. It is also important to remember that the more complex the design of the rotation-resistant rope, such as with SFP 19 or 36DD, the more imperative it is to use the proper D/d ratio. In multistrand designs, crossover points between strand layers are areas of high stress. Forcing the rope to bend over a small sheave will accelerate the rate of deterioration of the inner wires and strands and promote unbalance. WW's recommended D/d ratios are shown in Table 2.

Improper Sheave Maintenance. The most common operational problem with rotation-resistant ropes is improper sheave maintenance. Where a 6-strand construction may adapt to a loose or tight groove, a rotation-resistant rope will not be as forgiving. When the groove profile does not provide proper rope support in the sheave, the rope is pinched (tight groove) or flattened (loose groove). Either condition may cause a rotation-resistant rope to become unbalanced

For further information on seizing, handling and installation procedures, fleet angle, design factors and D/d ratios, please refer to WW's Bethlehem Wire Rope® General Purpose Catalog.

Although these ropes are termed "rotation-resistant," some slight rotation may occur, particularly in the early stages of the rope's life. This rotation may result in undesirable cabling in multipart systems, or rotation of the load in a single part. If this occurs, relieve the torque by disconnecting the most accessible end of the rope, and then reconnecting it.

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