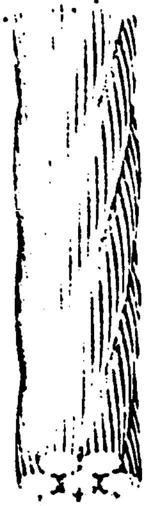
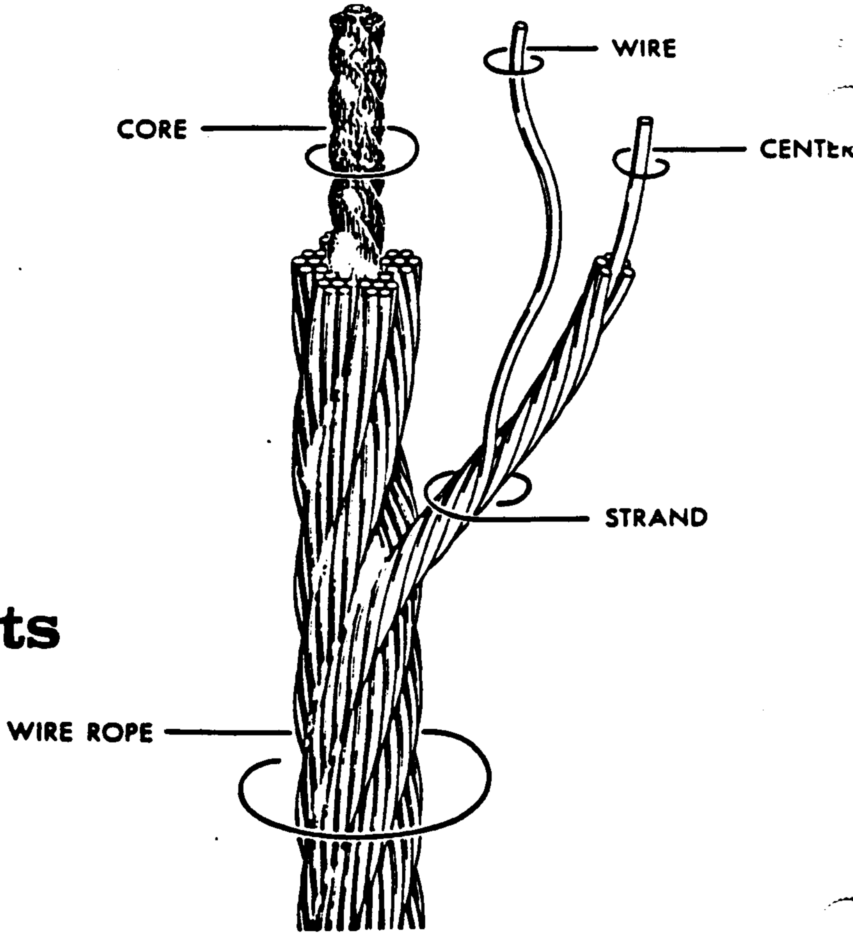
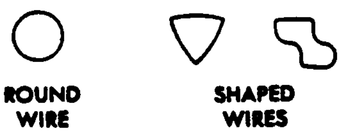




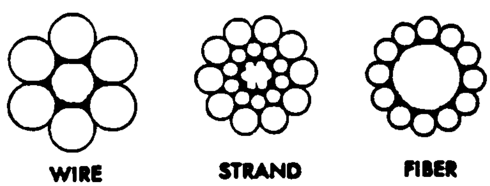
Component Parts

WIRE



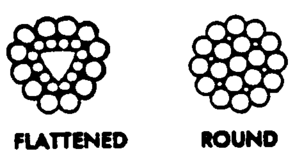
The basic element of a wire rope is a single metallic wire. It may be either round or shaped.

CENTER



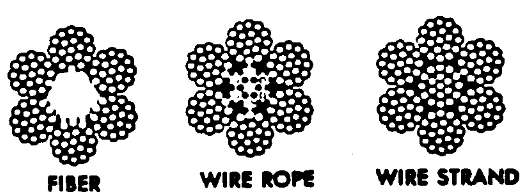
The center is the axial member of a strand about which the wires are laid. It may be cotton or polypropylene fiber or one or more wires.

STRAND



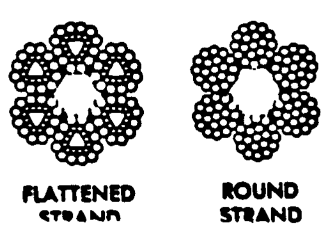
A strand is a plurality of round or shaped wires helically laid around a center in one or more layers.

CORE



The core of a wire rope is the axial member around which the strands are laid to form a wire rope. It may be either steel, natural fibers, or polypropylene.

ROPE



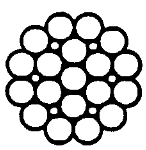
A number of strands laid helically around a core form a rope.

Strand Construction

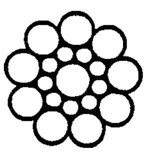
A strand consists of a specific number of wires of predetermined sizes, laid in layers around a center in a given pattern or construction. Each wire in a strand performs a specific function. The center serves as the base which supports the other wires in the strand. The intermediate layer of wires serves as a supporting arch for the outer layer of wires which in turn absorb the wear and tear of contact with sheaves, drums, and other surfaces. Each construction is designed to give each wire freedom of movement in relation to the adjacent wires.

For convenient reference rope constructions are usually grouped into classifications by the number of wires in their strands as follows:

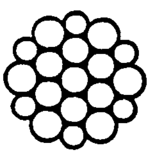
CLASSIFICATION	WIRES PER STRAND
6 x 7	7
6 x 19	16 through 26
6 x 37	27 through 49
8 x 19	16 through 26



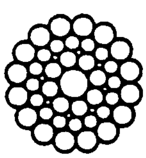
FILLER WIRE: Two layers of wire laid around a center wire, the inner layer having half the number of wires in the outer layer. Small filler wires, equal in number to the inner layer, are laid in the valleys of the wires of the inner layer. Example: 25 Filler Wire 1-6-6f-12.



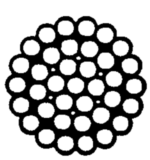
SEALE: Two layers of wire laid around a center wire, having any number of uniform size wires in the outer layer with the same number of uniform but smaller sized wires in the inner layer. The wires in the outer layer are cradled in the valleys between the wires of the inner layer. Example: 19 Seale 1-9-9.



WARRINGTON: Two layers of wire laid around a center wire, having two sizes of wire alternating in the outer layer and uniform sized wires in the inner layer. The large wires of the outer layer are supported in the valleys, and the smaller wires on the crowns, of the wires of the inner layer. Example: 19 Warrington 1-6-(6+6).



COMBINED PATTERNS: Two or more of the foregoing basic strand patterns may be combined to form other single-operation modifications. Example: 49 Filler Wire Seale 1-8-8f-16-16.



MULTIPLE OPERATION: A basic multiple layer one-operation strand covered one or more additional operations by one or more additional layers having any number of uniform sized wires in each. Example: 43 Filler Wire—2-Operation 1-6-6f-12/18.

Right Lay—Regular Lay

Left Lay—Regular Lay

Right Lay—Long Lay

Lays

The term "lay" in wire rope is used to denote three distinct features of rope construction:

1. The direction in which the strands are laid in the rope. This is described as either RIGHT lay or LEFT lay, with right lay the standard. In right lay the strands spiral to the right or clockwise; in left lay to the left or counterclockwise.

2. The relationship of the direction of the wires in the strands to the direction of strands in the rope.

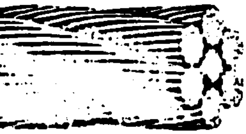
   REGULAR lay wire rope is made with the wires in each strand laid in the opposite direction to that of the strands in the rope.

   LANG lay wire rope is made with the wires of each strand laid in the same direction as the strands in the rope.

   In Regular lay rope the exposed portions of the wires are parallel to the center line of the rope. In Lang lay rope the wires are at an angle with the rope axis and much greater lengths of the individual wires are exposed. Regular lay rope is less liable to develop kinks in handling, is more stable, and is more resistant to crushing on drums than Lang lay rope. While Lang lay rope is more flexible and resists abrasion to a greater degree than Regular lay rope, its general use should be in accordance with specific recommendations. It should never be used with a swivel which will permit the rope to rotate and the lay to run out. Both ends must be securely fastened.

3. A unit of measure to describe the straight-line distance in which a strand makes one complete spiral around the core. The length of lay is related to the diameter of rope and provides a basis for rope inspection. The lay length is measured as illustrated.

For the many purposes for which wire rope is used and to meet the demand for strength, flexibility, toughness, hardness or corrosion resistance, Wireco wire rope is supplied in a wide variety of grades.



Grades

EXTRA IMPROVED PLOW STEEL (XIP)® is made of a special grade of steel that provides about 15 per cent greater tensile strength and greater toughness than IPS.

IMPROVED PLOW STEEL (IPS) is a tough and strong grade of wire developed to perform best under the widest variety of operating conditions.

PLOW STEEL has a lower breaking strength than IPS but a somewhat increased resistance to fatigue.

TRACTION STEEL is used exclusively in traction steel elevator ropes. It has greater strength than iron elevator ropes and greater resistance to wear.

ELEVATOR IRON is used exclusively for elevator ropes where the lesser strength is not a determinant and the abrasive action on the rope is negligible.

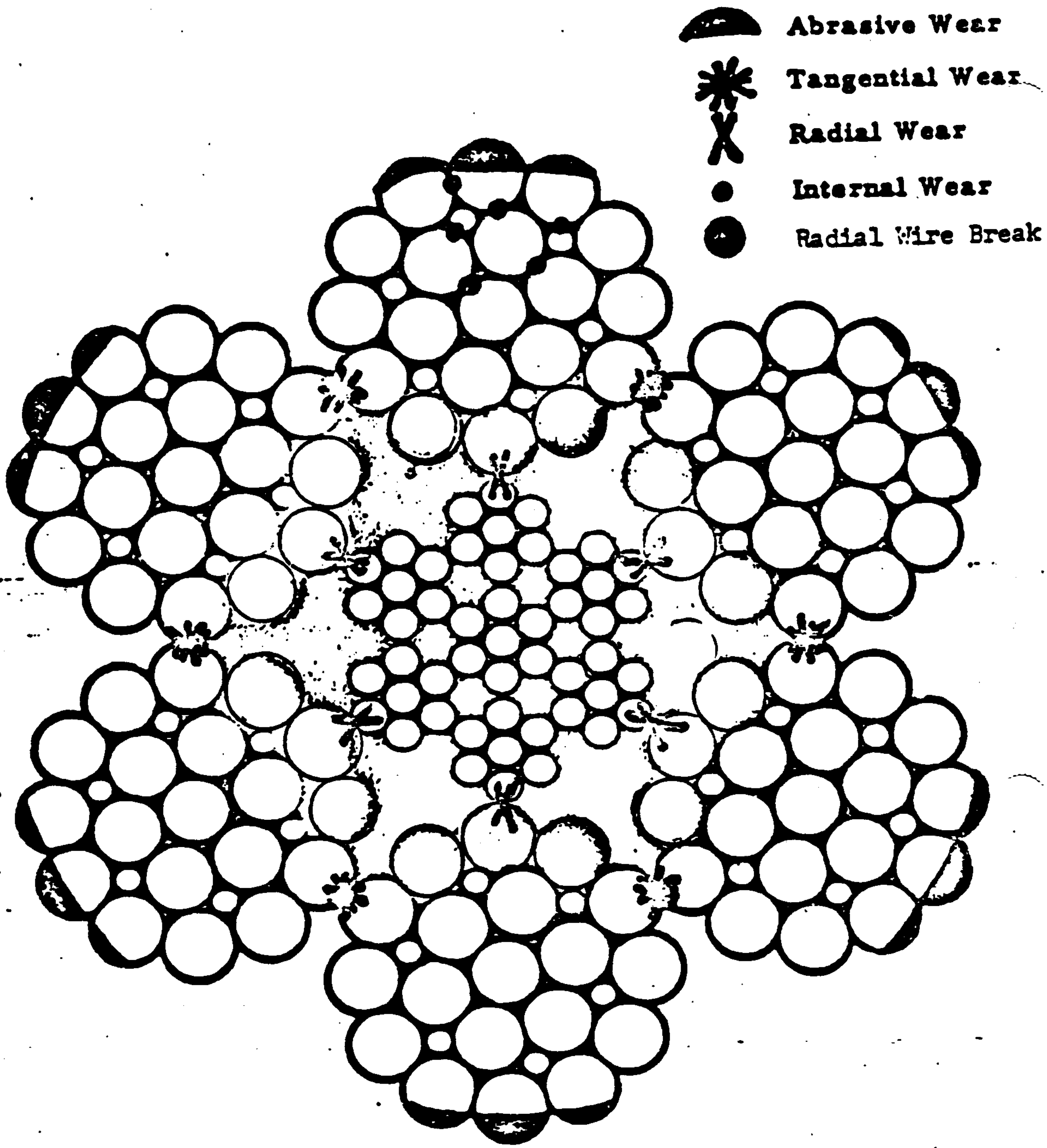
IRON is used primarily in sash cords and tillers where strength and resistance to abrasion are less important than flexibility.

STAINLESS STEEL is made from special alloy steel, usually containing 18% chromium and 8% nickel. It has a tremendous resistance to most corrosive actions and is used widely as yachting ropes and aircraft control cable.

BRONZE is used in two grades of copper alloy wire, commercial bronze and phosphor bronze. Both are relatively low in strength and have little resistance to wear. Their primary advantages are their non-magnetic qualities and their resistance to certain types of corrosion. Phosphor bronze is the stronger and tougher of the two.

AIRCRAFT wire, a specially drawn steel, has high tensile strength and high fatigue resistance. Its primary usage is in aircraft control cable. It is generally finished with a zinc or tin coating.

Wire ropes are also made of galvanized wire to combat corrosive action. The wires are coated with a uniform layer of pure zinc prior to their fabrication into wire rope. Depending on the process, ropes made of galvanized wire may have 90% to 100% of the strength of equivalent ropes made of bright wire.



6x19 - Type N
Wire Rope Core

Figure 1

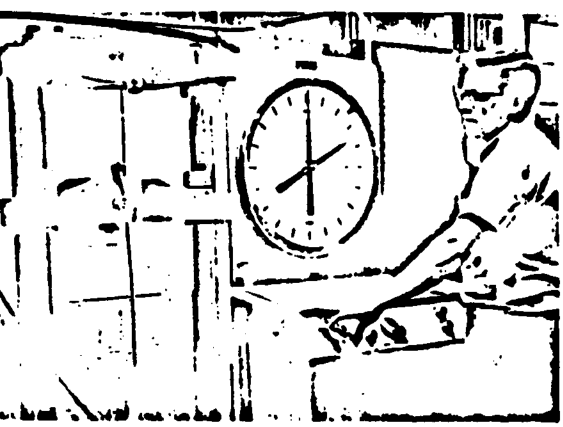
FACTORS AFFECTING THE SELECTION OF THE RIGHT ROPE

The key to the problem of choosing the best rope for the job at hand lies in the correct appraisal of five main factors:

1. **Resistance to breaking . . . STRENGTH**
2. **Resistance to bending and vibrational FATIGUE**
3. **Resistance to ABRASION**
4. **Resistance to CRUSHING**
5. **RESERVE STRENGTH**

It is not possible for any rope to excel in all of those factors. In fact, a high rating in one or more always means a low rating in others. The problem is first to analyze carefully the requirements of the job and then to select the rope which provides the best possible balance of the resistance factors, sacrificing the advantages of some which are the least essential in order to get the maximum benefit of those which will be the most useful.

1. STRENGTH . . . Resistance to breaking



First to be determined is the greatest load the rope will be called upon to bear. This will include not only the maximum dead weight, but the additional strains caused by abrupt starts and stops, shock loads, high speed operation, friction of sheaves, etc. For safe operation this figure is generally multiplied by five. If the load is especially valuable or if danger to human life is involved, a safety factor of 8 to 1 or 9 to 1 or even larger is often used.

2. FATIGUE...Resistance to bending and vibration

If a piece of wire is bent to and fro often enough, it will eventually break. This is due to the phenomenon called "metal fatigue." The same thing happens in some degree whenever rope is bent around sheaves, drums, or rollers. The sharper the bend, the faster the fatigue does its work. Accelerating the speed of travel also speeds fatigue and reverse bends (i.e., bending first one way, then the other) speed it even faster. Vibration in any part of the rope has much the same effect.

Fatigue will be greatly reduced if sheaves and drums have at least the minimum diameter recommended for each size of rope. Other fatigue situations are best relieved by changing to a more flexible type of rope. Here, the X chart on page 37 will help to choose a construction which strikes the best balance between resistance to fatigue and resistance to abrasion. The general rule — the greater the number of wires in the strand, the greater will be the resistance of the rope to fatigue.

3. ABRASION

Abrasion is perhaps wire rope's most common and most destructive enemy. It occurs whenever a rope rubs against or is dragged through any foreign material. This rubbing weakens the rope by removing metal from the crowns of the outside wires.

As in fighting fatigue, the best cure for excessive abrasion is often to change to a more suitable rope construction. Here, too, the X-chart will be helpful. And again, the general rule is that fewer and therefore larger wires provide greater resistance to abrasive wear.

But changing rope constructions may not be necessary. Abnormal wear may be due to faulty alignment of sheaves, wrong groove diameters, a wide fleet angle, improper drum winding, or other causes which are described in the Use and Care section of this handbook.

4. CRUSHING

Rope can be crushed by outside pressures, but much more prevalent is crushing that is due to operation of the rope under excessive pressures on plain faced drums, or in grooves which do not provide proper support to the rope, or on drums where multiple winding or cross-over winding occurs. In such cases, if the load cannot be eased, one solution is to replace the offending sheaves or drums with others better suited to the job. Otherwise, the rope must be replaced by one with a construction that is better designed to resist the abuse.

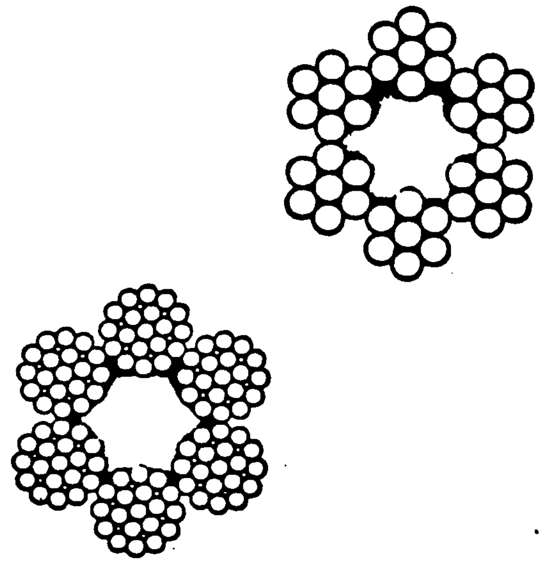
If fiber-core rope is being used, this means a change to a steel core because of the greater physical support the steel core gives. Strands cannot be mashed into a steel core as they can into a relatively soft fiber core. It is also possible that a flattened strand rope will help to prevent crushing because its triangular-shaped strands form a rigid core-protecting arch under compression.

Equally important is the fact that regular lay ropes resist crushing better than lang lay ropes.

5. RESERVE STRENGTH

The reserve strength of a wire rope is the combined strength of all the wires it contains, *except* those in the outside layer of the strands. So the more rope wires there are in a strand, the greater is its reserve strength. The reason is that the smaller the outside wires, the greater is that part of the rope's cross-sectional area occupied by its interior wires.

Reserve strength is always important, but never more so than where wire rope failure might cause serious or fatal accidents. Wherever that danger exists, thorough and frequent inspection by a competent person is most advisable. If that is not feasible, then the reserve strength factor should be given all the greater consideration.



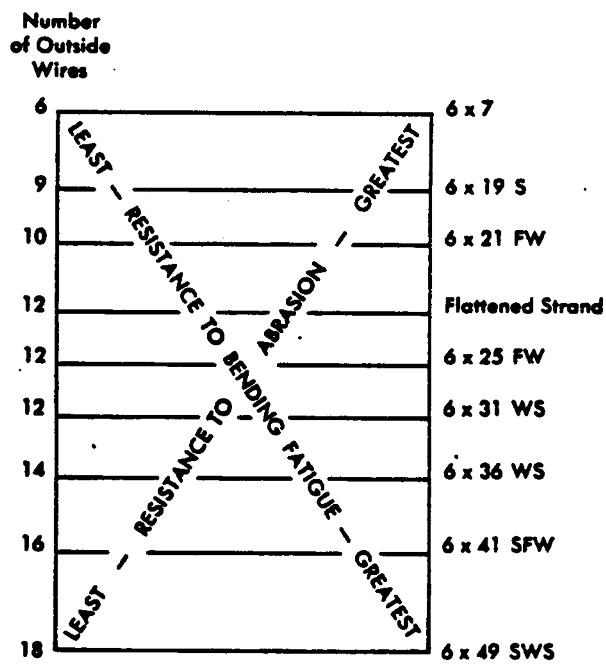
X-CHART...Abrasion resistance vs. flexibility

It is possible, of course, that the job does exist where precisely the right wire rope can be selected to satisfy every possible demand for resistance to abrasion and crushing plus maximum resistance to bending fatigue. But it is not likely.

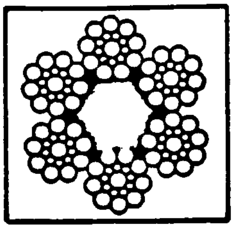
As a rule, a compromise is necessary. You may, for a example, settle for less than optimum resistance to abrasion in order to get maximum flexibility which is more important for the job in hand.

This chart illustrates at a glance how any one of the most used wire rope constructions compares with the others in resistance to abrasion and to bending fatigue. These are the two factors which govern most decisions in selecting wire rope. And as a rule they require the most judgment.

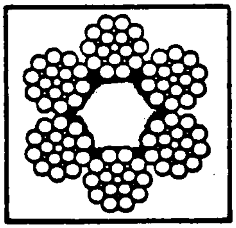
Generally, the safe course in selecting a wire rope is to stay as close as possible to the center of the X. There you come closest to an even balance between resistance to abrasion and to bending fatigue. Reading up or down along either leg of the X, one quality gains as the other loses.



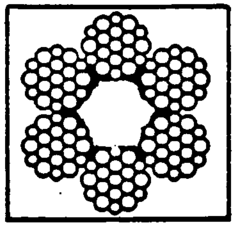
But always remember that you can't have everything. Rarely, if ever, will the wire rope engineer's dream of an absolute match of job, equipment, and rope be realized. Usually the goal is the most efficient and economical of all available compromises.



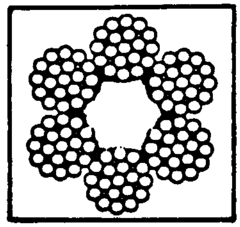
6 x 19 SEALE



6 x 21 FILLER WIRE



6 x 19 WARRINGTON



6 x 25 FILLER WIRE

6x19 Classification

This classification includes *all 6-strand round strand ropes* with from 16 through 26 wires in each strand. All have the same weight and breaking strength so they are grouped into one classification (6 x 19) and given one set of values.

6 x 25 FILLER WIRE

To most wire rope users, 6 x 19 means 6 x 25 Filler Wire, so-called because, counting the six small filler wires, there are actually 25 wires per strand. This is a compact construction with solid support for the wires; hence, its resistance to crushing is good.

6 x 25 FW is near the center of the X-Chart. That means it has an almost exactly even balance between resistance to abrasion and to fatigue in relation to other ropes. For that reason it is the "work horse" of wire ropes, used for more purposes than any other construction. It is also a favorite for slings up to about 1¼ inches in diameter.

Reserve strength of 6 x 25 FW is 44% of its rated strength. This figure (44%) will have more meaning as it is compared with other constructions.

6 x 21 FILLER WIRE

A comparison of the cross-section diagrams on this page shows clearly that the outer wires of the 6 x 21 FW are larger and fewer than those of the 6 x 25 FW construction. The 6 x 21 FW has 10 and the 6 x 25 FW has 12. As mentioned previously, fewer but larger outside wires means better resistance to abrasion but somewhat less resistance to bending fatigue. So 6 x 21 FW is a good choice where high abrasive action is accompanied by moderate bending. For abrasion resistance it rates the call over 6 x 25 FW; for flexibility it is preferable to 6 x 19 Seale.

In addition to being used as a drag rope, 6 x 21 FW is widely used on vertical shaft hoists, drag and slackline scrapers, inclines, and sometimes rotary and cable tool drilling rigs.

Reserve strength is 36% compared with 44% for 6 x 25 FW.