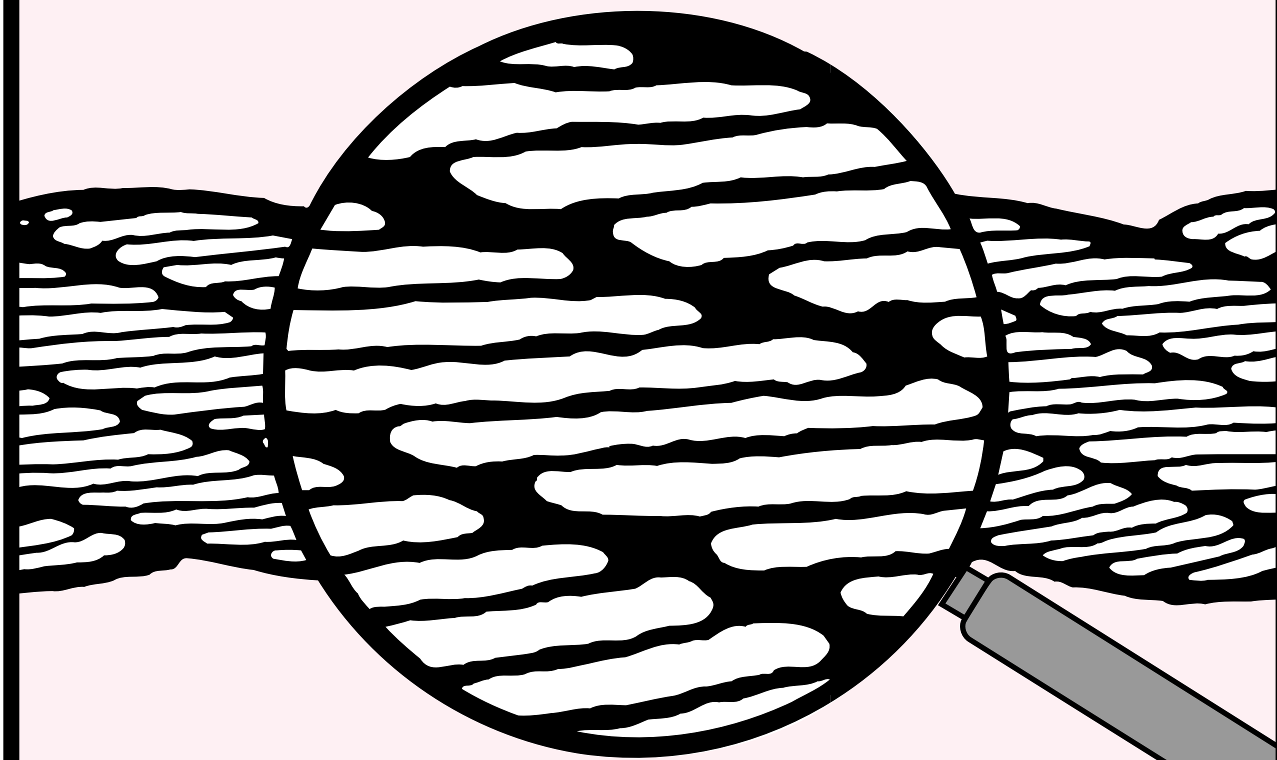
CASAR®

SPECIAL WIRE ROPES



Wire Rope Inspection and Examination

Wire Rope Inspection and Examination

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FOREWORD

In the UK two Codes of Practice deal with the Inspection and Examination of steel wire ropes, B.S.7121: Part 1 1989 „Safe use of Cranes“ and B.S. 6570 : 1986 „The selection, care and maintenance of steel wire ropes“.

B.S. 7121 deals specifically with cranes, much of the information it contains relating to ropes has been taken from B.S.6570. However, B.S.7121 does have additional useful information about the discard criteria to be applied when assessing the condition of a rope.

B.S.6570 is a comprehensive Code of Practice and gives information on the selection, care, maintenance, inspection and examination of general purpose ropes.

1. Why must wire ropes be inspected and examined?

Wire ropes are consumable items with a limited life. During service the physical properties of a wire rope will change.

At the commencement of service, the individual wires and strands settle into position and the rope breaking strength increases. After reaching a maximum it decreases rapidly (Fig. 1).

This decrease in breaking strength is caused by the progressive loss of the metallic cross-section due to abrasion and corrosion, by wire breaks and by changes in the structure of the rope.

A chain represents a series connection of load bearing elements. If only one link in the chain breaks, the whole lifting device will fail completely. A wire rope represents a parallel connection of load bearing elements and consequently it can still be operated safely after one or more wire breaks.

Generally, there is a steady rate of increase in the number of wire breaks during the life of the rope. Fig. 3 shows the increasing number of wire breaks as a function of the number of cycles in a bending fatigue test.

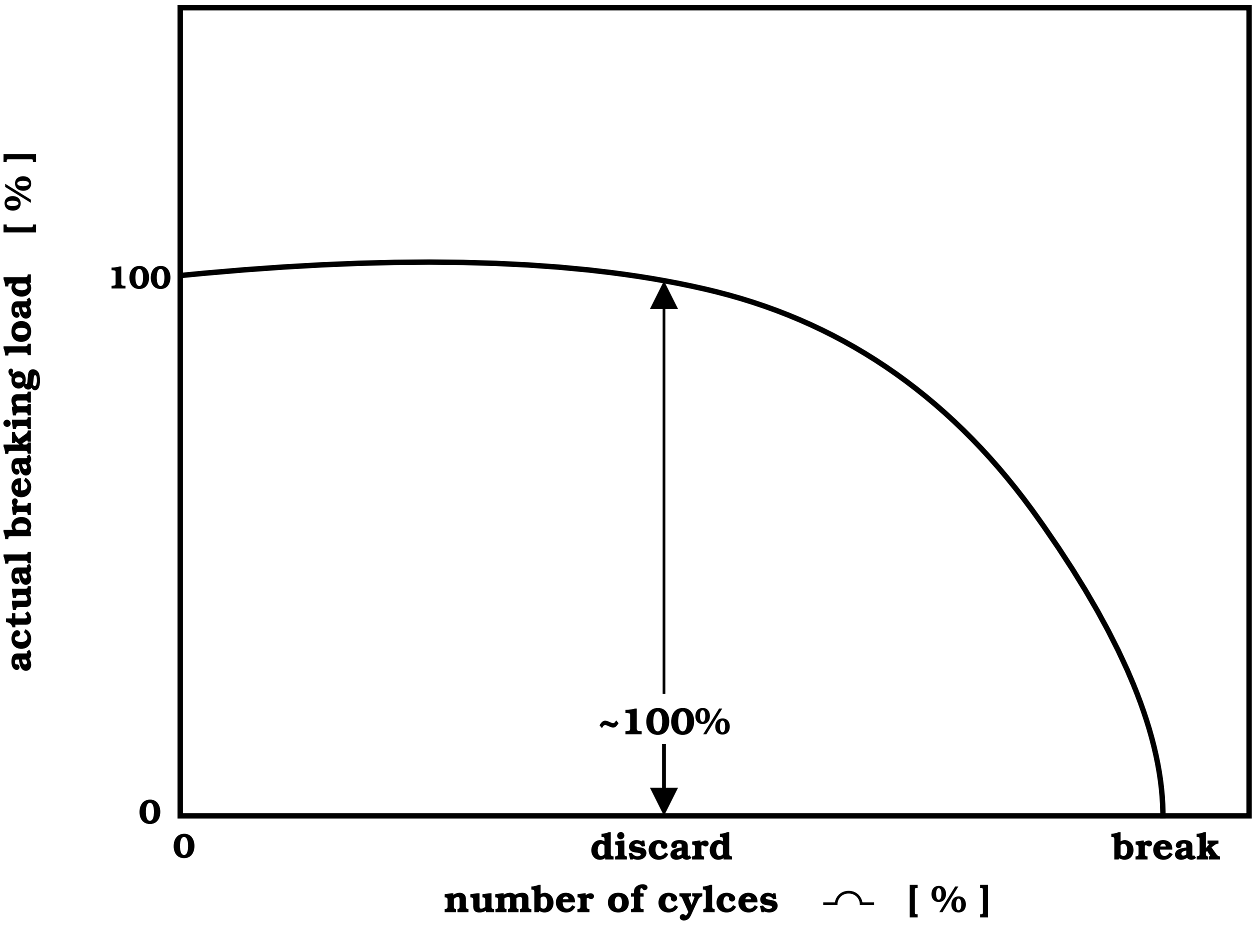


Fig. 1

One of the objectives of inspecting and examining a wire rope is to supervise the normal process of deterioration so that the rope can be removed from service before becoming a hazard to safety. Another benefit of the inspection and examination procedures is to detect unexpected damage or corrosion.

Inspections and examinations, properly carried out, ensure the discard of a rope before failure. In addition, precautions can be taken to avoid a recurrence of damage or excessive wear to future ropes.

2. What is Inspection, what is Examination?

An inspection is a careful and critical assessment of the rope and fittings carried out without dismantling.

An examination is a careful and critical assessment of the rope and fittings carried out by a competent person. This should include, where necessary, a visual assessment of the internal condition of the rope, supplemented by other means such as measurement and non destructive testing. In order for end fittings to be examined properly they may need to be dismantled.

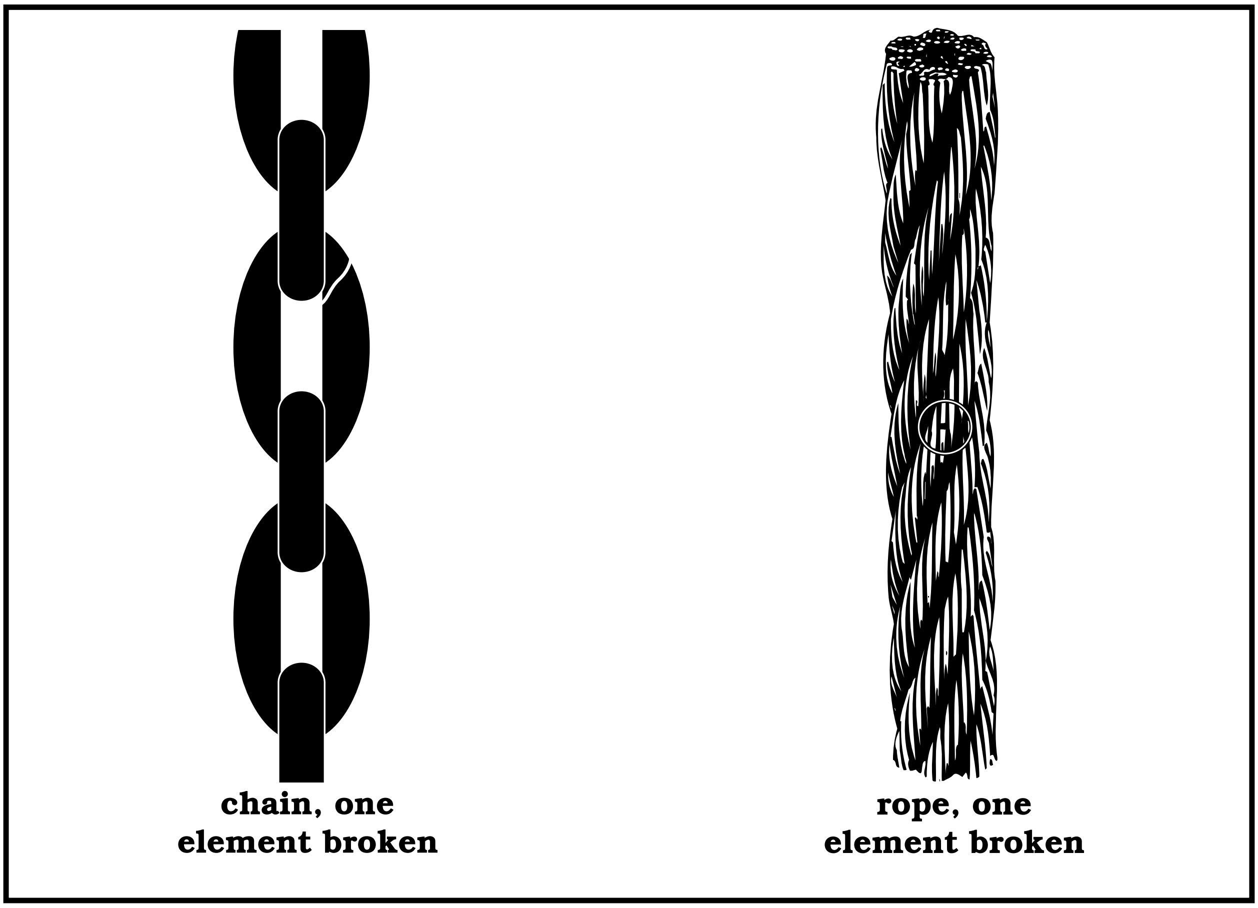


Fig. 2

3. When must wire ropes be inspected?

Wire ropes should be inspected at the start of each shift, work period or more frequently, depending upon past experience. Usually this inspection will be carried out by the operator of the individual piece of equipment or possibly by a member of the work force specially appointed.

The inspection should be a visual assessment of the condition of as much of the rope length as possible, including the points of attachment to the equipment.

When a rope has been removed from equipment and later fitted to the same or different equipment, it should be inspected after fitting but before resuming service.

If at any time a change in the rope condition is suspected, it should be reported immediately and the equipment taken out of service until the rope has been examined by a competent person. As a result of this examination it may be prudent to review and amend the scope and frequency of the inspections.

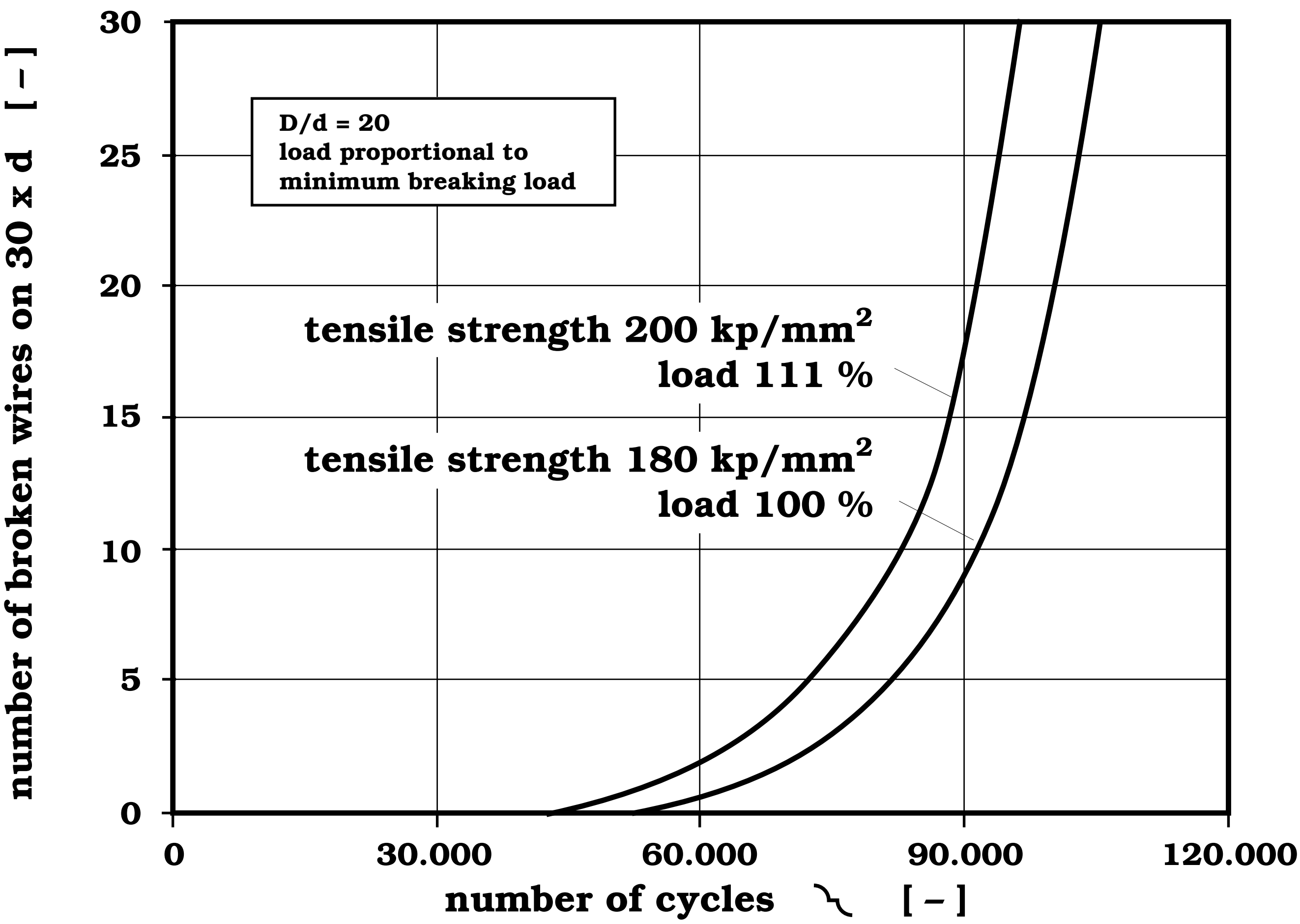


Fig. 3

4. When must wire ropes be examined?

The Factories Act 1961 Section 26, The Construction (Lifting Operations) Regulations No. 1581 and the Offshore Installations (Operational Safety, Health and Welfare) Regulations 1976 No. 1019 all require a thorough rope examination at least once in every period of six months.

The Shipbuilding and Ship-repairing Regulations 1960 requires a thorough examination every three months or monthly after the first broken wire has been discovered.

One of the statutory regulations listed above will apply to the location and type of rope using equipment being examined.

It is the responsibility of the individual to institute and maintain a programme of periodic examination which satisfies the requirements of the appropriate regulations and the specific operating conditions of the equipment.

Examination should be carried out at regular intervals. The intervals should be scheduled so that any damage will be detected early.

According to B.S. 6570 examinations should be carried out "at regular intervals, the frequency of which will be influenced by the following:

a) statutory requirements
b) type of appliance and/or design of the system
c) operational environmental conditions
d) method and frequency of operation
e) manufacturer's recommendations
f) results of previous inspections and examinations
g) experience with previous ropes on the appliance or system"

During the first few weeks after the installation of a new rope the daily inspection can be used to monitor performance as the rope might have been fitted incorrectly or the type of rope might not be suited to the equipment.

The intervals between the examinations should also be reduced after the first broken wire or other damage has been detected.

If the rope has been overloaded or if non- visible damage is suspected, the intervals between examinations should be reduced accordingly.

Moreover, the examinations should be carried out when the rope is put back into service after long periods of standstill.

If a lifting device has been dismantled and re assembled, the rope must be examined before it is allowed to operate again.

5. Survey of removal

A wire rope must be removed if one or more of the following criteria can be satisfied:

1) Broken wires.

A wire rope must be discarded if the permissible number of wire breaks is reached or exceeded. It must also be replaced when local concentrations of wire breaks occur.

Chapter 7 covers in detail the subject of the permissible number of wire breaks according to British Standard 6570 and the statutory requirements.

2) Reduction in diameter.

Reduction in diameter can be caused by abrasion, corrosion or a local failure of the rope core. According to B.S. 6570 a wire rope should be discarded „when the rope diameter anywhere is reduced to 90% of the nominal diameter in the case of six and eight strand ropes“. Considering the fact that a rope is allowed to have an oversize of 4% when new, this figure would allow for a diameter reduction of 14%, which seems to be excessive.

For multi- strand ropes B.S. 6570 recommends a detailed examination "if the rope diameter falls to 97% of the nominal, or rises to 105% of the nominal", because "discard may be necessary".

3) Corrosion.

Corrosion may be external or internal, general or localized. According to BS 6570, a wire rope should be discarded "when the surface of the wires is severely roughened or pitted, or if the wires are slack within the strands due to wastage".

4) Rope deformation

a) Waviness (Fig. 4a). This deformation, while it may not necessarily affect the strength of the rope, can transmit pulsation and produce uneven rope wear. When the rope is laid on a level surface under no load, the maximum height of the "wave" should not be greater than the nominal rope diameter + 1/3, otherwise the rope should be removed from service.

b) Birdcage (Basket Deformation)
A birdcage (Fig. 4b) develops when the outer layer of strands be comes longer than the inner layer or layers. The condition may occur as a result of incorrect fitting, tight sheaves, shock loading, incorrect use of a swivel or the application of a heavy load to a new rope before the strands have settled into position. Ropes with a birdcage should be discarded.

c) Loop Formations. Wires or groups of wires may form a line of loops parallel to the axis of the rope (Fig. 5a). This deformation is often caused by shock- loading. Loop formations are a justification for discard.

d) Loose Wires. Where loose outer wires (Fig. 5b) are found without any adjacent mechanical damage, the most likely cause will be corrosion and the rope should be removed from service. Where loose wires have been caused by mechanical damage, a full examination will decide if the rope can remain in use.

e) Nodes (Fig. 5c). A node is a local increase in rope diameter with the core easily visible between several covering strands. It can be caused by shock loading or, in the case of fibre main core ropes, by the absorption of moisture. A node is a justification for discard.

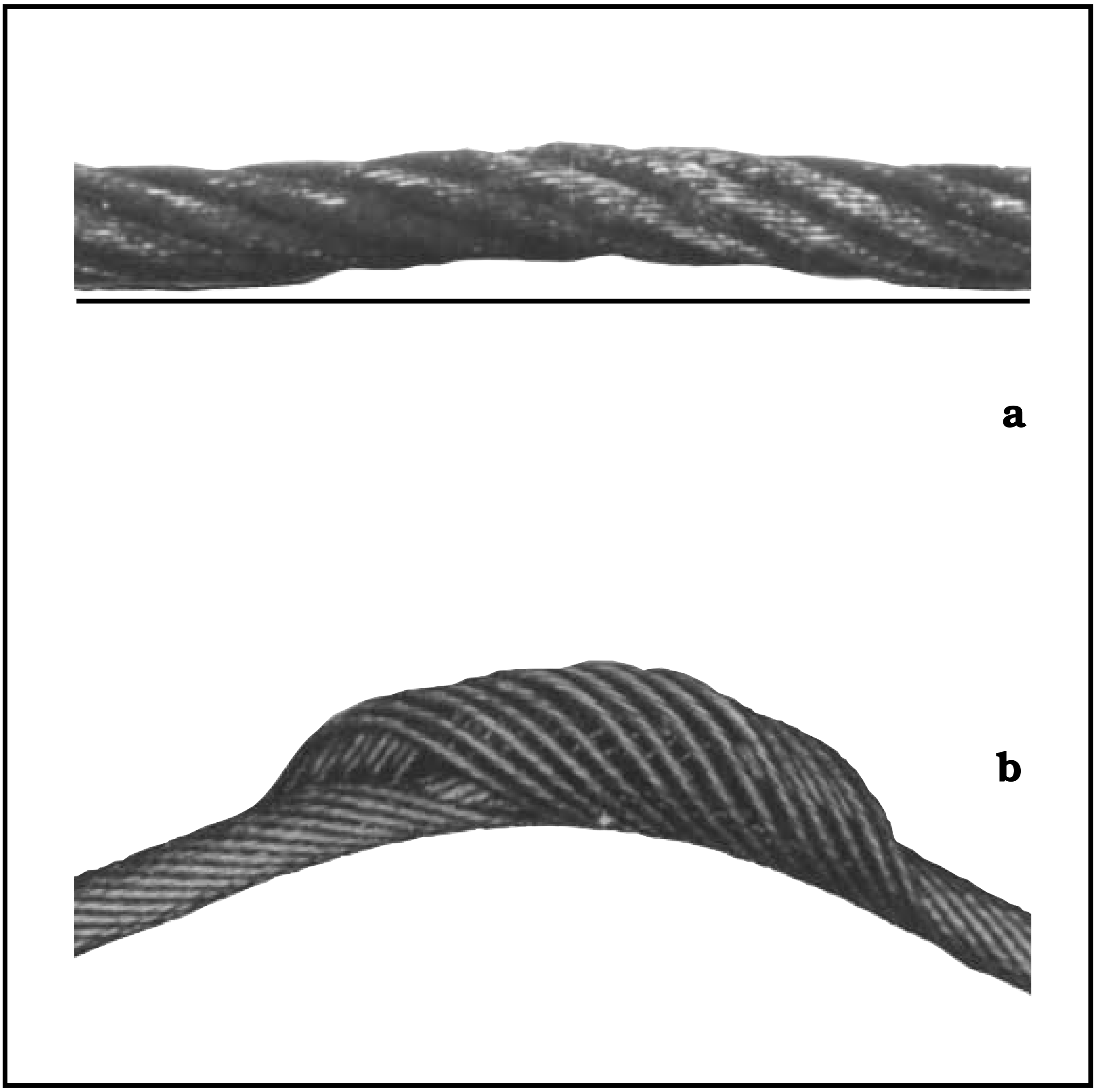


Fig. 4

f) Thinning of the rope (Fig. 6a). Thinning is a reduction in the diameter of the rope over a short length. It is often associated with older fibre cored ropes usually in areas of sustained heavy loads over sheaves. The disintegration and loss of the core can allow one of the covering strands to take the place of the core. When this condition occurs in ropes with IWRC the distortion will most often be in the vicinity of the termination away from drum. The most likely cause is rope rotation which has allowed the rope to unlay, resulting in the overload and reduction in diameter or failure of the IWRC.

g) Misplaced Outer Wires. Misplaced outer wires are wires forced out of position along the line of the rope to form small flat-

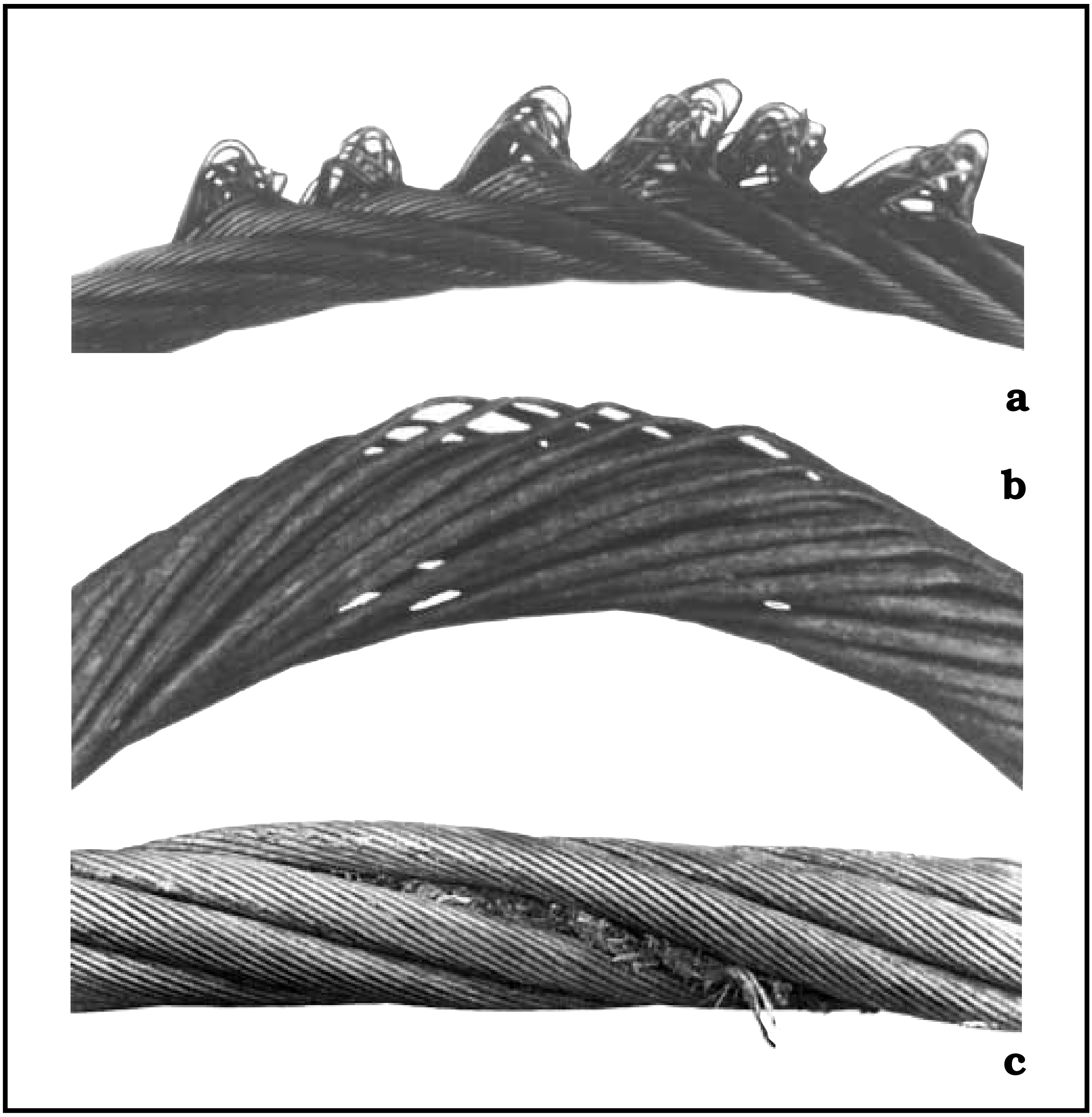


Fig. 5

tened loops. This can be caused by bad drum spooling or by the rope being drawn across a sharp edge. Langs lay ropes are often worst affected. Misplaced outer wires are a justification for discard.

h) Kinks (Fig. 6b). Deformation caused by a loop in a rope being tightened when the rope cannot rotate about its axis to release the torque. The tight bend or kink thus formed can result in a serious loss of strength due to unbalance in the lay lengths. Ropes with kinks must be discarded.

i) Flat areas (Fig. 6c). A flattening can be caused by bending the rope severely over the rim of a sheave or any sharp object with the wires on the inside of the bend being forced out of position.

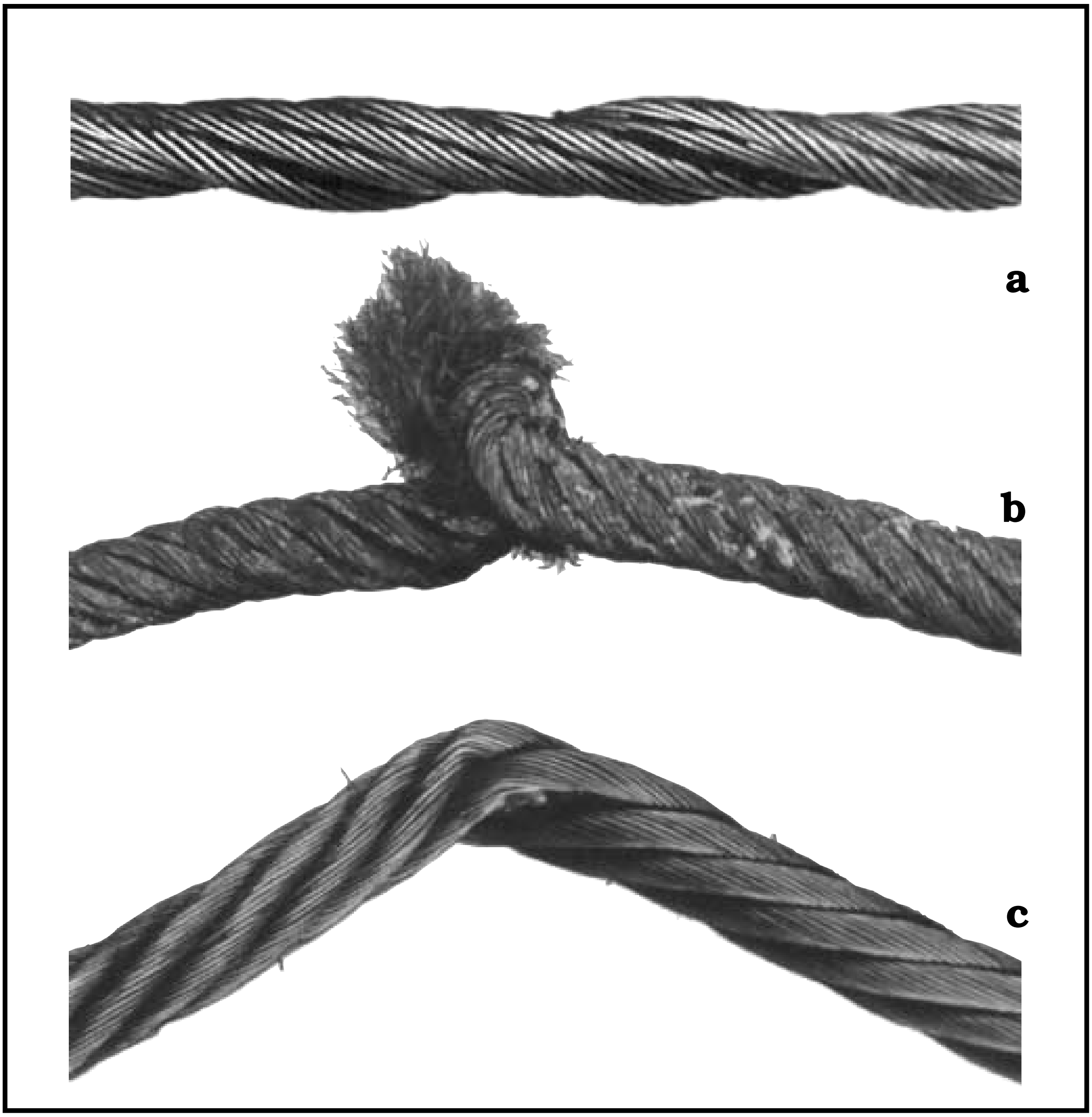


Fig. 6

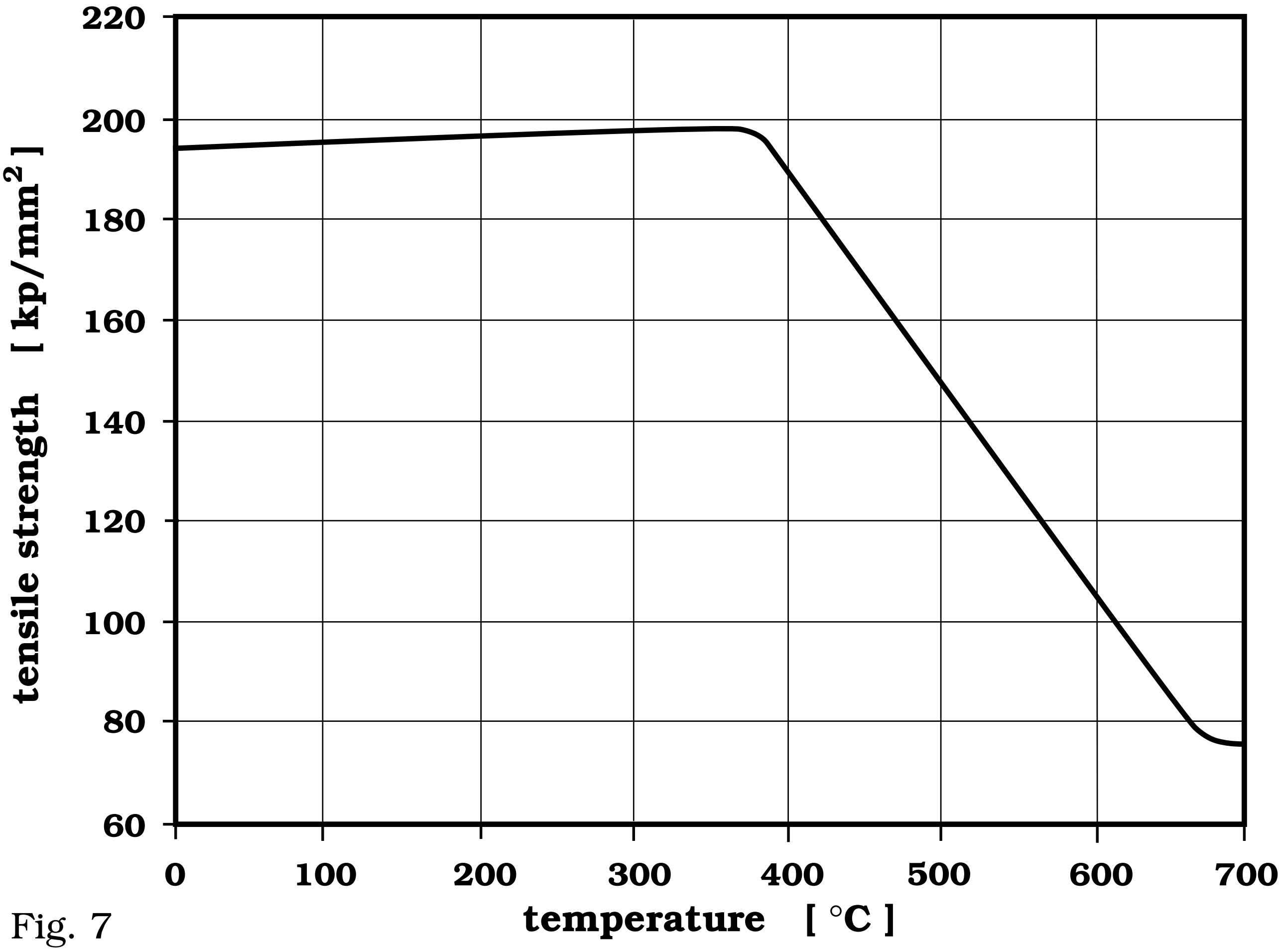


Fig. 7

Ropes with flat areas should be discarded.

5) Damage caused by heat.

Heating rope wires to approximately 300° C and over will lead to considerable reduction in tensile strength of the wires (Fig.7). Wire ropes which have been subjected to excessive heat must be discarded.

6. Where must wire ropes be inspected or examined?

During an inspection or a periodic examination by a competent person, the full length of the rope should be checked.

The following areas may require more detailed attention:

a) Rope zones with the highest number of cycles. During normal day to day operations some sections of a rope length will suffer a greater number of bends over sheaves and drums than others. It is in these areas where the greatest number of fatigue wire breaks can be expected.

b) Pick- up points. When a lifting device picks up or releases a load with the same sections of rope regularly in contact with sheaves and drums, those sections of the rope are subjected to increased stress.

c) End fittings. At, or closely adjacent to, terminal fittings the elasticity of the rope is restricted and the geometry “frozen”.

Depending upon the type of fitting, there will be additional pressure on the rope and the section close to the area of contact between rope and fitting is often the focal point for increased stress caused by vibration.

The danger of corrosion is also increased by the retention of moisture in the area of contact between rope and fitting.

d) Equalising sheaves. Ropes which are often considered to be stationary around equalising sheaves can be subjected to high numbers of bend cycles caused by the uneven spooling of two drums, by swinging loads or by frequency vibrations. As the rope might never leave the equalising sheave, moisture can be trapped in the area of contact between rope and sheave and cause corrosion.

e) Zones of maximum wear on drums. Pick- up points and cross- over points on the drum are subjected to increased wear and therefore require special attention. Misplaced and broken wires caused by scrubbing can be expected at cross- over points. The damage can be severe where the fleet angle is excessive.

With multiple layer spooling, the first layer of rope on the drum should be tightly wound to provide a firm base for subsequent layers. This applies in particular to plain drums and parallel grooved drums, e. g. Lebus. Slack winding or lateral movement between turns of rope will affect the spooling of subsequent layers and can cause damage.

The point where the rope is squeezed between the drum flange and the previous turn as it rises to commence the next layer, is an area of accelerated wear and should be given special attention.

f) Sheaves. Sheaves should be examined for general condition and tested for freedom of movement. Using a groove gauge the tread radius can be measured.

The radius of the grooves should be equal to the nominal rope diameter plus + 6% to + 10%.

Undersize grooves will seriously reduce the service life of the rope due to the effects of crushing. Oversize grooves reduce the service life due to premature fatigue caused by insufficient support in the groove area.

Where the rope surface pattern is imprinted into the sheave tread, the sheave should be replaced.

g) Rope sections working in a hostile environment. High temperature can considerably reduce the breaking load of a wire rope. Temperatures of up to 250°C will not affect the tensile strength of the wire, but temperatures of only 50°C can cause leaching of the rope lubricant.

The consequent severe wire to wire friction will result in a marked reduction of rope performance. The exposure of rope to chemical action can greatly increase the effect of corrosion.

In each of the areas where wire breaks or other defects are found, the number and description along with the location, must be recorded.

7. Discard number of wire breaks

The Construction (Lifting Operations) Regulations requires a rope to be replaced when the number of broken wires reaches 5% of the total number of wires in the rope in 10 x d.

The Factories Act, The Shipbuilding and Ship-repairing Regulations and the Offshore Installations Regulations do not specify a particular number of broken wires for discard and leaves this decision to the discretion of the examiner.

The Health and Safety at Work Act requires the provision and maintenance of plant and systems of work that are, so far as is reasonably practical, safe and without risks to health.

The table on Page 25 shows the recommended number of discard wire breaks for CASAR special wire ropes. For the number of discard wire breaks in other types of multi-strand ropes the user is advised to contact the rope manufacturer.

Depending on the factor of safety, the assessment of broken wires in 6 and 8 strand ropes working over steel sheaves is divided into two groups :

1) Factor of safety less than 5 : 5% of the number of outer strand wires excluding Filler wires.

2) Factor of safety greater than 5 : 10% of the number of outer strand wires excluding Filler wires.

When broken wires are detected, the number and position, along with the examiner's opinion of the general rope condition, will decide whether or not the rope should be discarded.

If local concentrations or groups of broken wires are found, the rope should be discarded when:

a) three or more broken wires are found in the close proximity of the termination,

b) three or more broken wires are found in one strand or

c) five broken wires are found between two adjacent strands within a length of 10 x rope diameter.

If the number of broken wires does not justify discard, the position and number of all broken wires found must be recorded in the rope examination Log Book.

When broken wires are found in close proximity to a permanent termination, such as a white metal or resin secured socket and the general condition of the remainder of the rope is acceptable, it may be decided to cut the rope and re make the termination. In such cases it is recommend that the socket is submitted for N.D.T. and heat treatment. Care must be taken to ensure sufficient turns of “dead” rope remain on the drum after the termination has been remade.

8. Rope examination procedure

8.1 Equipment

In order to carry out a proper inspection, the following tools should be available:

a list of the discard criteria (this manual)
a rope caliper or vernier gauge
a steel tape
a piece of white chalk
a wax pencil (dark coloured)
a roll of adding machine paper
a sheet of typing carbon paper
a screwdriver
a magnifying glass
a pencil
a roll of marking tape
two sets of groove gauges
a piece of cleaning cloth
a wire brush
a pair of gloves
a note book or an inspection form
the previous inspection records

8.2 Locating of wire breaks

Identification of wire breaks can be by visual and physical examination or by the use of electromagnetical equipment (see section 9).

The first step in wire rope examination is to find the rope section with the greatest concentration of wire breaks. This is normally done by first visually inspecting the full length of the rope.

In some cases it can be helpful to spool the rope slowly through the hand. Special attention has to be paid and strong protective gloves must be worn.

A piece of wood held on the surface of a moving rope will be deflected by the protuding ends of broken wires. In the same way, a soft cotton or similar type cloth held against a moving rope will be caught by protruding ends and thus detect the broken wires. Smooth synthetic material is less suitable for this purpose.

The detection of broken wires in the strand valleys can be difficult. The use of a scraper or piece of shaped wood will help clean out the valleys. The use of a wire brush on a dirty, heavily lubricated rope can loosen, but not always remove, old lubricant and the brush may have to be cleaned frequently with a solvent.

Where solvents are used to clean the rope surface, they should be used sparingly and the rope section should be thoroughly lubricated afterwards. A light lubricating oil used with a wire brush is preferred for softening old lubricant which can then be wiped off with a cloth. When the worst affected sections of rope have been found, their boundaries should be marked by chalk or tape for further examination.

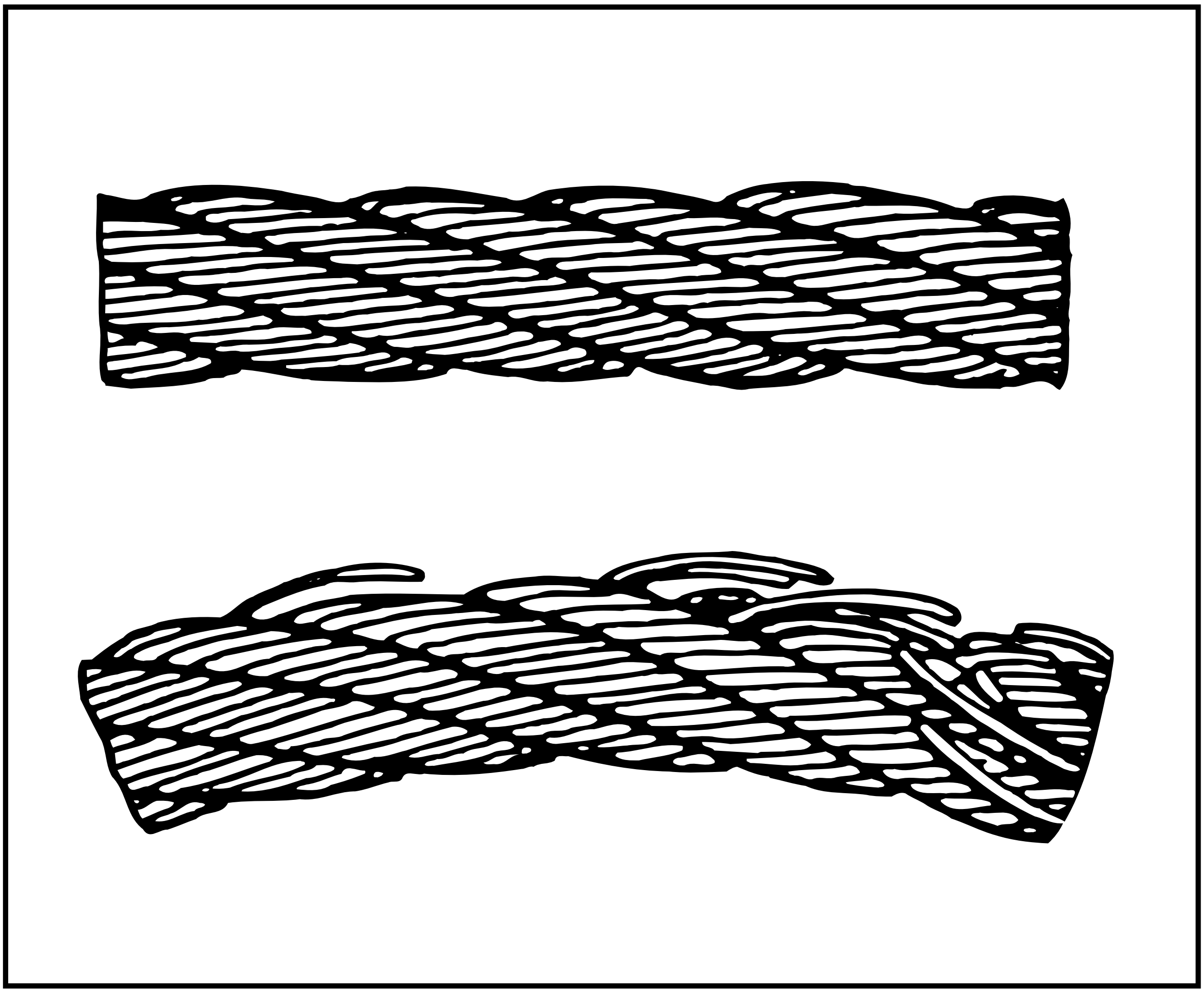


Fig. 8

A gauge should be set to a length of 10 x d. This can now be moved within the boundaries to locate the section with the maximum number of wire breaks. The breaks in 10 x d should be counted and entered in the records.

With thin ropes, valley breaks can be detected by strongly flexing the unloaded rope (Fig. 8).

8.3 Determination of the rope diameter

The rope diameter should be measured on receipt for conformity with the specification. British Standard (B.S. 302:1987, Stranded steel wire ropes, Part 1. Clause 5.1) allows for a tolerance of - 1% to + 4% of the nominal rope diameter.

The generally accepted method of measuring rope diameter for compliance with the Standard is to use a caliper with jaws broad enough to cover not less than two adjacent strands. The measurements must be taken on a straight portion of rope at two points at least 1 metre apart. At each point two diameters at right angles should be measured. The average of the four measurements is the actual diameter.

After the rope has made the first few cycles under low load, the rope diameter should be measured at several points. The average value of all the measurements at each point must be recorded and will form the basis of comparison for all future measurements.

The measurement of the rope diameter is an essential part of all inspections and examinations. It ensures the maximum diameter reduction does not exceed the recommended figure. As stated in 5.2. British Standard 6570 recommends that a wire rope should be discarded when the diameter of the rope is reduced to 90% of the nominal diameter.

A comparison of the measured data with the recorded previous values can detect an abnormal rate of reduction in diameter. Coupled with assessment of previous rope examination data, the probable date of rope renewal can be predicted.

If we examine the cross-section of a six-strand wire rope, we will find that measuring the thickness of the rope over the crowns (Fig. 9a) will produce a higher value than measuring it over the valleys (Fig. 9b). The actual diameter of the rope is defined as the diameter of the circumscribing circle.

When using a conventional caliper, wire ropes with an even number of outer strands (four-, six-, eight-, ten-, and multi-strand) ropes must be measured from crown to crown. The advantage of a proper wire rope caliper with measuring plates is that even if the measurement is carried out "incorrectly", adjacent crowns are always included, so that the actual diameter is determined at any section (Fig. 10).

Measuring the diameter of wire ropes with an uneven number of outer strands (three-, five-, seven, or nine-strand ropes) is more complicated: a crown on the one side of the wire rope always has a valley as a counterpart on the other side of the wire rope. A conventional caliper, therefore, has to be applied diagonally to the axis of the rope, so that at any time a crown adjacent to a valley is covered. Again a wire rope caliper with measuring plates is definitely to be preferred as it always includes strand crowns.

In all cases during periodic examinations where the measurements are to be recorded, the rope should be measured as already described. Where the „roundness" is being checked to detect potential faults, two diameters, one at right angles to the other can be taken and noted in

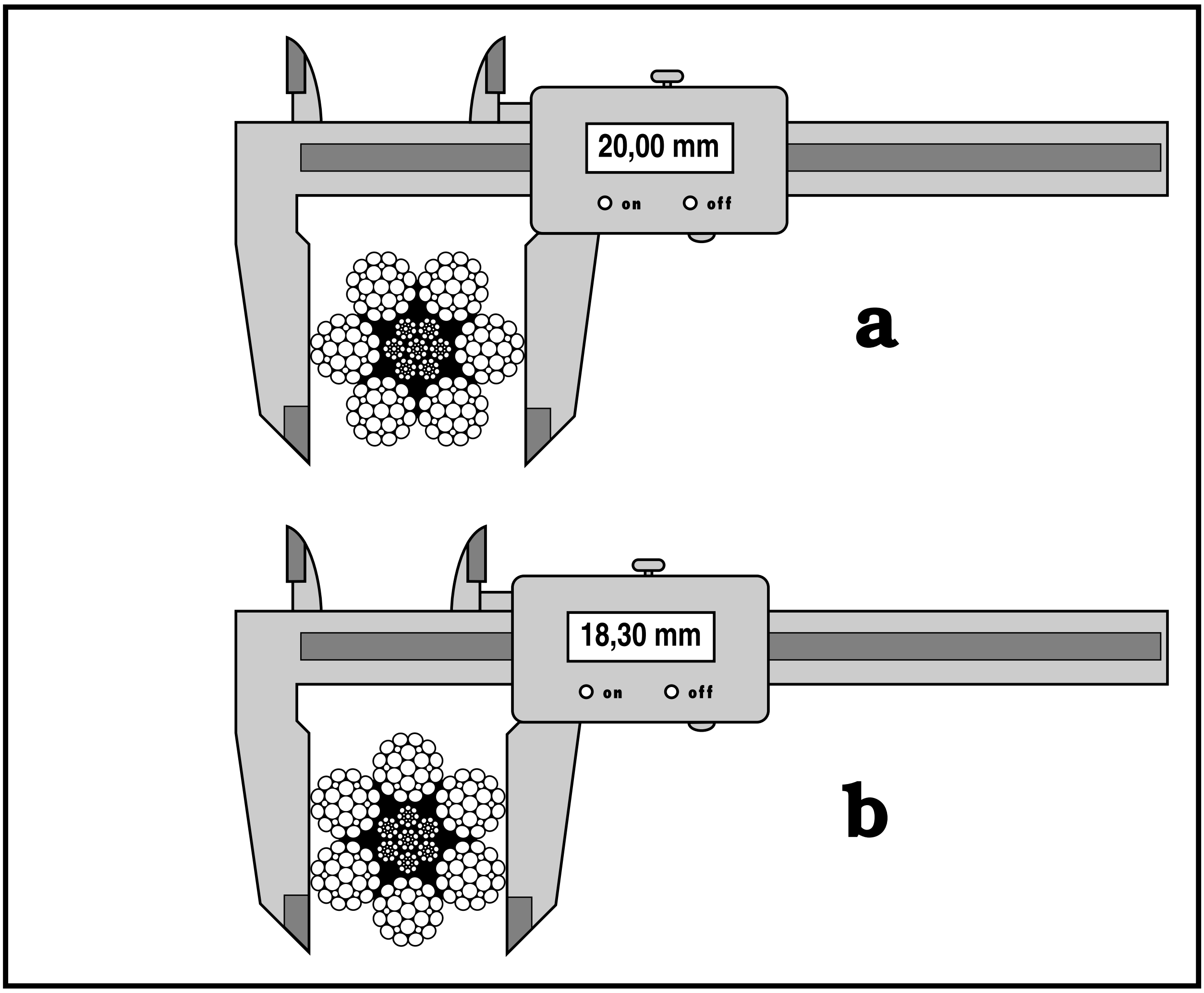


Fig. 9

the records. The entry into the records might read „Rope diameter : 20.4/20.5mm“.

8.4 Measuring rope lay

After a rope has been fitted to the appliance, its length cannot be measured again accurately without a great deal of trouble. The purpose of measuring the length of lay is to detect any increase in the rope length which may have been caused by corrosion, core deterioration or rope rotation (unlaying). With a new rope the wires and strands should be allowed to settle into their permanent position. Six or seven lifting cycles with a light to medium load are recommended before measuring the lay of the rope. To minimise error, the measurement should be made over four lays and the length divided by four to find the average lay length.

On eight strand ropes the eight, sixteenth, twentyfourth and thirtysecond strands must be marked. Using a straight length of the rope and with the rope under no load, first mark any strand on the crown with a piece of chalk: this strand now becomes “crown zero”. Excluding this strand, count the next eight strands and mark the eighth strand with chalk. Exclude the eighth strand and repeat this procedure a further two times. The measured length between the outer chalk marks is then divided by four to give the lay length.

As a rough check on the overall accuracy of the chalk marking, the length of lay for eight strand ropes is approxima-

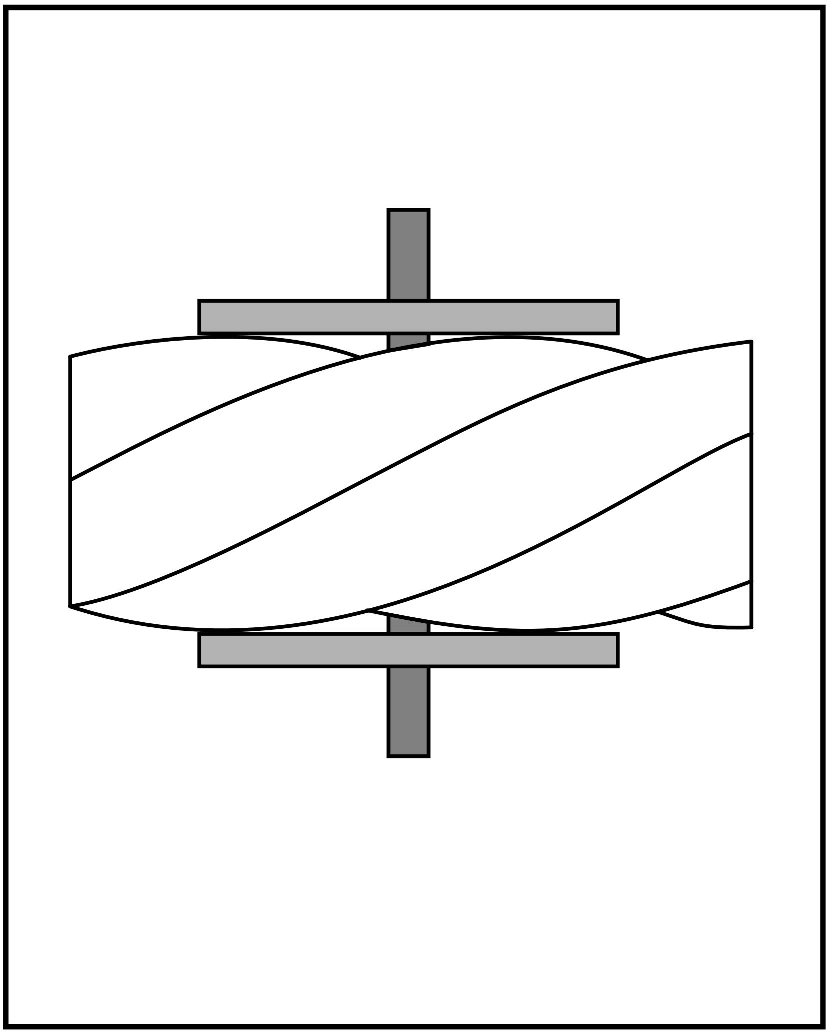


Fig. 10

tely between 6.25 and 6.5 x the diameter of the rope e.g. using a lay length of 6.5 x rope diameter, four lay lengths of a 32mm diameter rope will be 32mm x 6.5 x 4 = 832mm.

An alternative method of measuring the rope lay is to secure the free end of the roll of adding machine paper to the rope with adhesive tape. The paper is rolled out over the rope and simultaneously the wax pencil is drawn over the paper, providing a clear print of the outer wires of the rope. The finished print can be filed for comparison with later measurements.

A third method is to wrap typing carbon papers round the rope under the roll of paper. By rubbing along the paper with a piece of cardboard, the carbon marking on the underside of the paper can be confined to the tops of the strand crowns.

8.5 Checking the stability of the rope

A rope in good condition will have all strands tightly laid. A screwdriver inserted between strands when twisted, should meet with stiff resistance. If the screwdriver can be twisted between different pairs of strands without much resistance, a full examination should be carried out.

The unskilled use of a screwdriver or Marlin Spike to examine the rope core can cause serious damage to the rope.

8.6 Changes in rope structure

In addition to the examination areas detailed in section 4, deformation caused at any point in the main working area can move along the rope. Waviness, and in particular, a birdcage can be moved along the rope by the action of the sheaves. A degree of slackness in the outer cover of a multi- strand rope may not be sufficient to form an immediate birdcage. However, slackness can be “squeezed” along the rope. With the normal length of rope out any slackness in the outer cover will usually be found at the end termination or where the rope meets the drum.

8.7 Inspecting sheaves and drums

Remarks in this section are intended to apply equally to sheaves and drums.

A tight groove in a sheave or drum will subject the rope to enormous radial pressure. Rapid deterioration and premature wire failure, particularly in the valleys between strands, can be expected (Fig. 11, A).

On the other hand a wide groove will not provide essential support to a rope under load. Oval shaped deformation is produced resulting in uneven distribution of the load between individual wires with consequent early failure (Fig. 11, C).

Sheaves can be checked with gauges which are available on the open market. The use of specially made circular templates is preferred.

The recommend size for a sheave gauge is the nominal rope diameter + 6% to +10% (Fig. 11, B). In order to establish the size of a sheave groove, templates for the sizes above and below the recommended size will be required.

The sides and tread of sheaves which have been in use for some time are often heavily coated with old lubricant, some of which may first have to be removed with a scraper. By inserting the template as far as possible and drawing it through the remaining lubricant, the fit of the template relative to the sheave tread can be assessed.

The correct template should be in contact with the sheave tread for about 130°. If the template only touches the side flanges, the

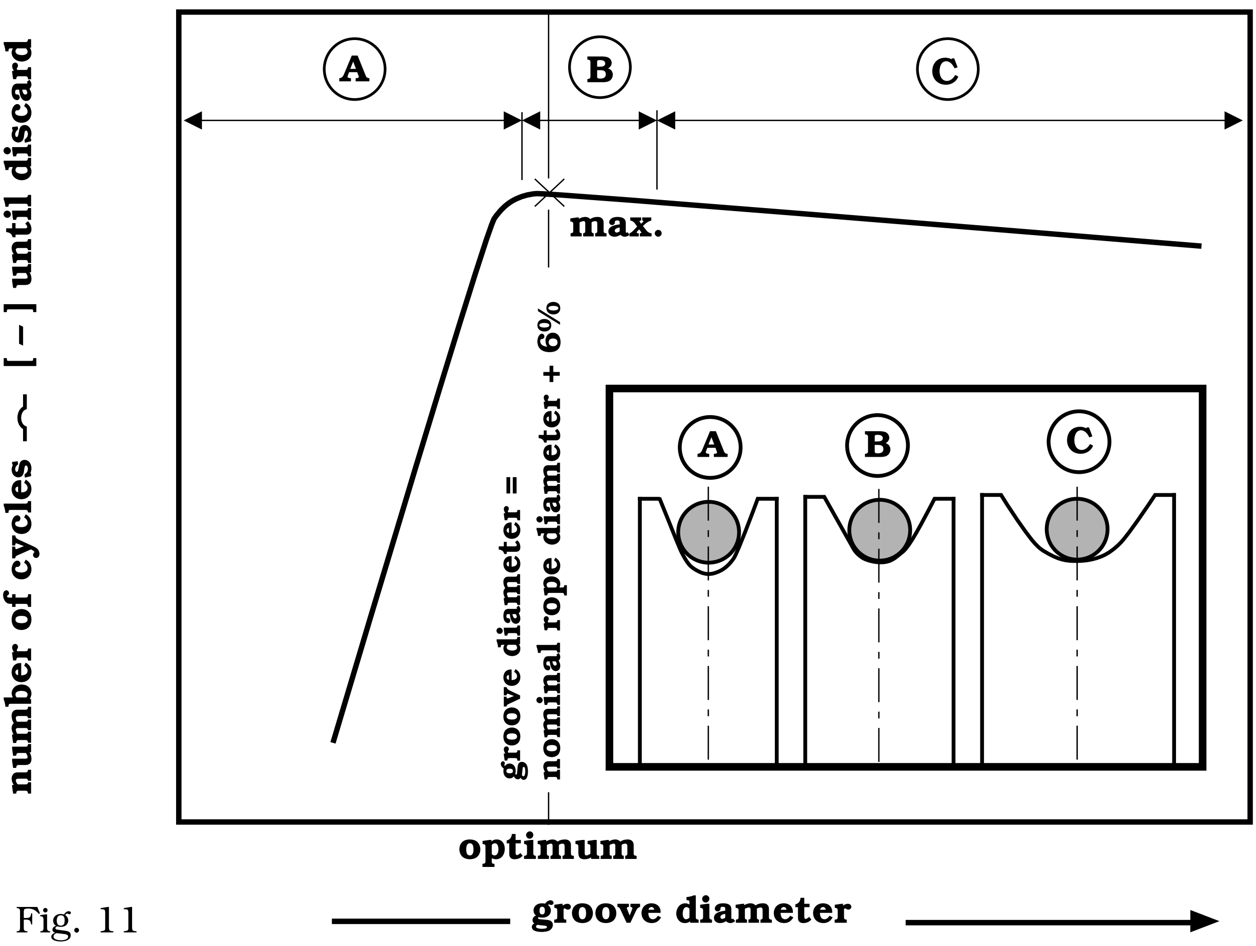


Fig. 11

groove is too tight. If the template touches only the bottom part of the tread, the groove is too wide.

Attention should also be given to the flanges of the sheaves. Absence of lubricant, scratching or unexpected wear on one side will indicate (a) misalignment of the sheave and (b) the danger of torque being induced into the rope due to the rope rolling down the flange into the tread.

The tread should be cleaned and carefully examined for any sign of ridging or imprinting. In the case of imprinting with the rope profile the rope in service may have caused the damage and is unlikely to be seriously affected. A replacement rope will not fit exactly into the imprint and will suffer serious damage during the early part of its service.

When a rope change is made, the sheaves should be checked for eccentricity and the bearing for wear and free running.

9. Electro-magnetic wire rope examination

After a period in service surface wear and/or a number of wire breaks will indicate the rope condition has deteriorated and discard may be imminent. Specific working conditions however, may

Fig. 12

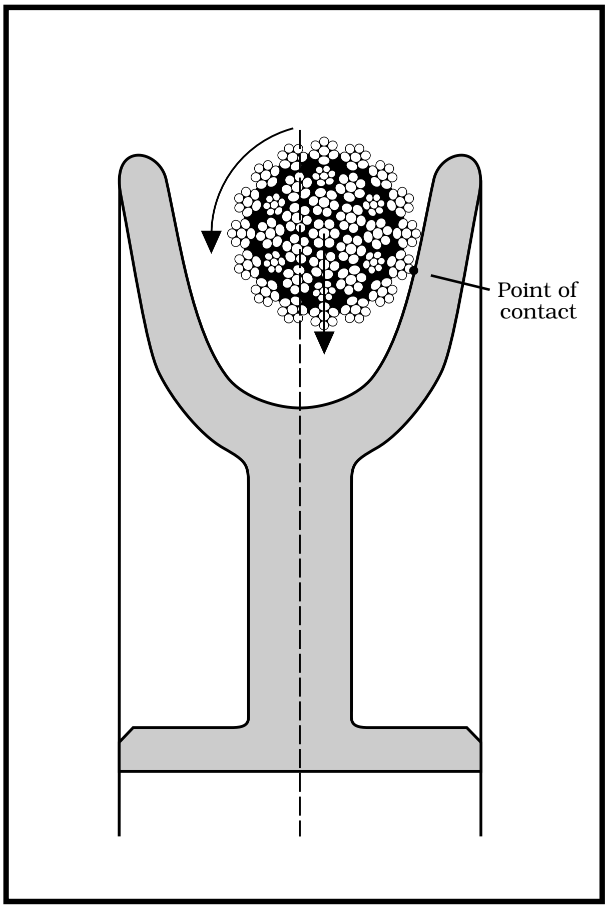


Fig. 13

lead to internal wire breaks and to internal loss of metallic area. It may be surprising to learn that this applies in particular to ropes which, for safety reasons, are operated with large diameter sheaves and high factors of safety.

Dynamically loaded ropes or ropes which are subjected to torque when working, can suffer from internal wire breaks caused by overstrained interior rope elements. In addition, when the reeving system includes sheaves lined with plastic or all plastic sheaves, these sheaves offer more elastic support than steel sheaves. The pressure between outer wires and the sheave grooves can be reduced to such an extent that with some rope constructions the first wire breaks will occur, not on the surface, but within the rope. In all these cases electro- magnetic testing will allow non-destructive examination and appraisal of the rope's internal condition.

Electro-magnetic testing equipment available on the market allows - depending on individual design - indication or continuous recording of localised damage such as single broken wires, breaks of strands, soldered and welded joints as well as wire pitting and even detection of reduced metallic area caused by corrosion and abrasion over the whole rope length.

The data are plotted as a function of the rope length, which is continually measured either during the inspection or, if a recording is done, during the following analysis. In this way every signal on the recording can unmistakably be related to a zone on the rope. This method allows a more precise visual inspection of those sections of the rope which showed exceptional inconsistencies during the electro-magnetic inspection. Furthermore, recording the data during regular elec tro-magnetic inspections makes it possible to compare the results with previous recordings. In this way the advance of the deterioration of the rope can be ascertained.

Electro-magnetic testing equipment for wire ropes was already being developed at the beginning of the 20th century. Only very few specialists could use the equipment properly but over the past few years the use of these instruments has been greatly improved so that they are now at the command of a much wider range of users.

It is likely that within a few years there will be equipment on offer which not only records measured data but also - by means of a micro computer - will process the data with regard to amplitude and frequency. In this way the equipment will provide the examiner with data such as frequency curves and the accurate assessment of the reduction in breaking strength.

At the moment instruments are being developed which, apart from the data mentioned above, can also record the rope diameter and the lay length of the rope. This will enable them to register out-of-roundness of the rope diameter, corkscrew-like deformations or changes of the lay lengths along the rope length.

For inspection a test head is clamped around the rope. Then the whole length of the rope is pulled through the test head. If this is not possible, as in the case of suspended ropes of rope ways, the test head is drawn along the wire rope. During this procedure all test data are transmitted via cable or radio to an amplifier. The test data are indicated either optically or acoustically, recorded on magnetic tape or represented graphically during the test. An electro-magnetic test instrument is shown in Fig. 14.

Calibration of the testing equipment requires great care. A recommended method of checking the function and accuracy of the equipment is to attach lengths of wire, having diameters equal to the largest and smallest sizes in the rope, along the first metres of rope length. By means of sellotape these wires can be secured in the strand valleys. At the beginning of the recording strip

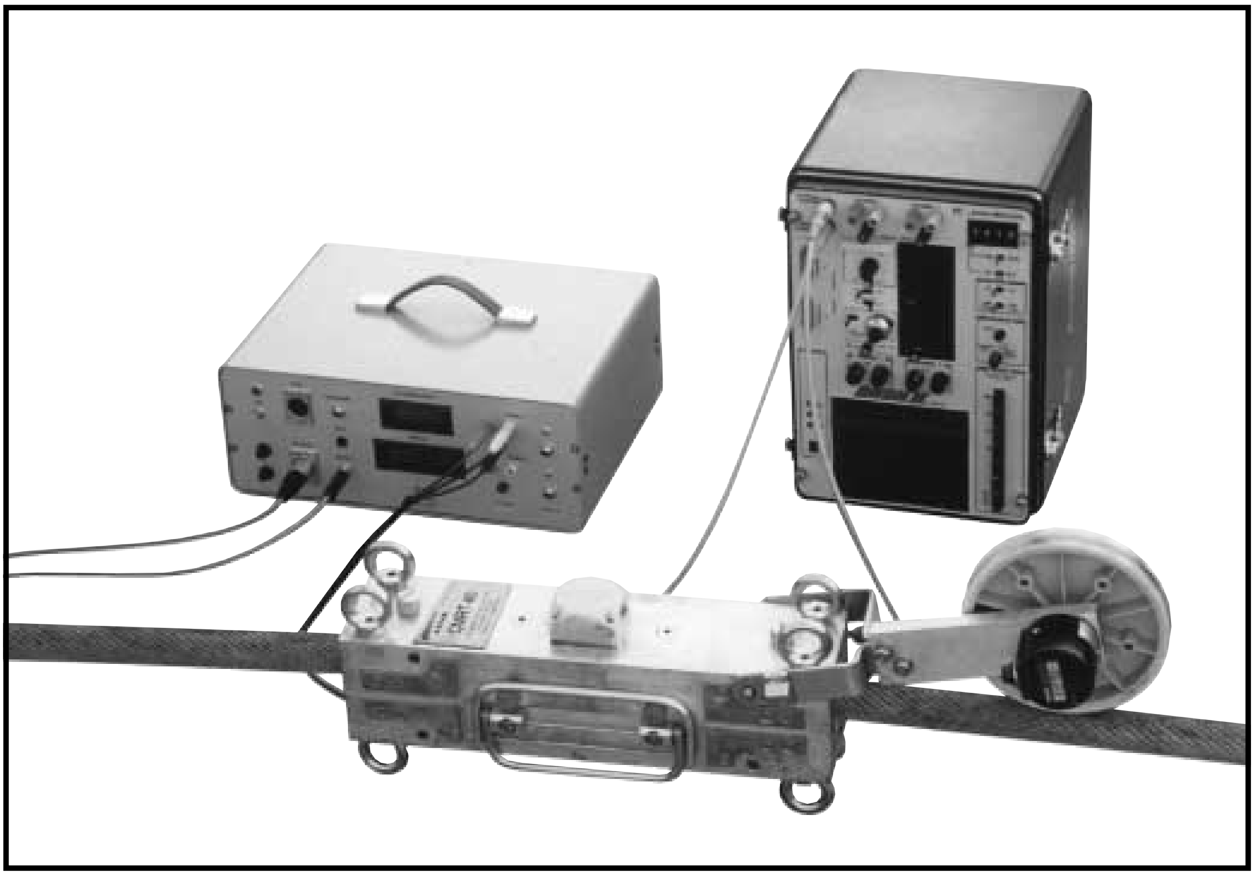


Fig. 14

chart the examiner will obtain reference data indicating the size of the amplitudes of the test wires.

Fig. 15a illustrates a typical diagram of a rope section with wire breaks. Fig. 15b shows the recording of a rope section affected by corrosion.

Selecting the suitable test instrument, competent handling and the correct interpretation of the data require a lot of experience and expert knowledge. Various universities, test institutes as well as commercial firms, render electro-magnetic inspection of wire ropes as a service.

The discard numbers of wire breaks specified in the Standards refer solely to external wire breaks. Appraising the condition of the wire rope with regard to internal wire breaks is therefore left to the inspector; he would be well advised to discard a wire rope when the total number of external and internal wire breaks, added together, reaches the discard number of wire breaks specified in the Standards.

Electro-magnetic tests can not, and must not, totally replace visual inspections. Yet, they provide valuable additional information on the conditions of wire ropes and must be regarded as a useful addition to the visual inspection.

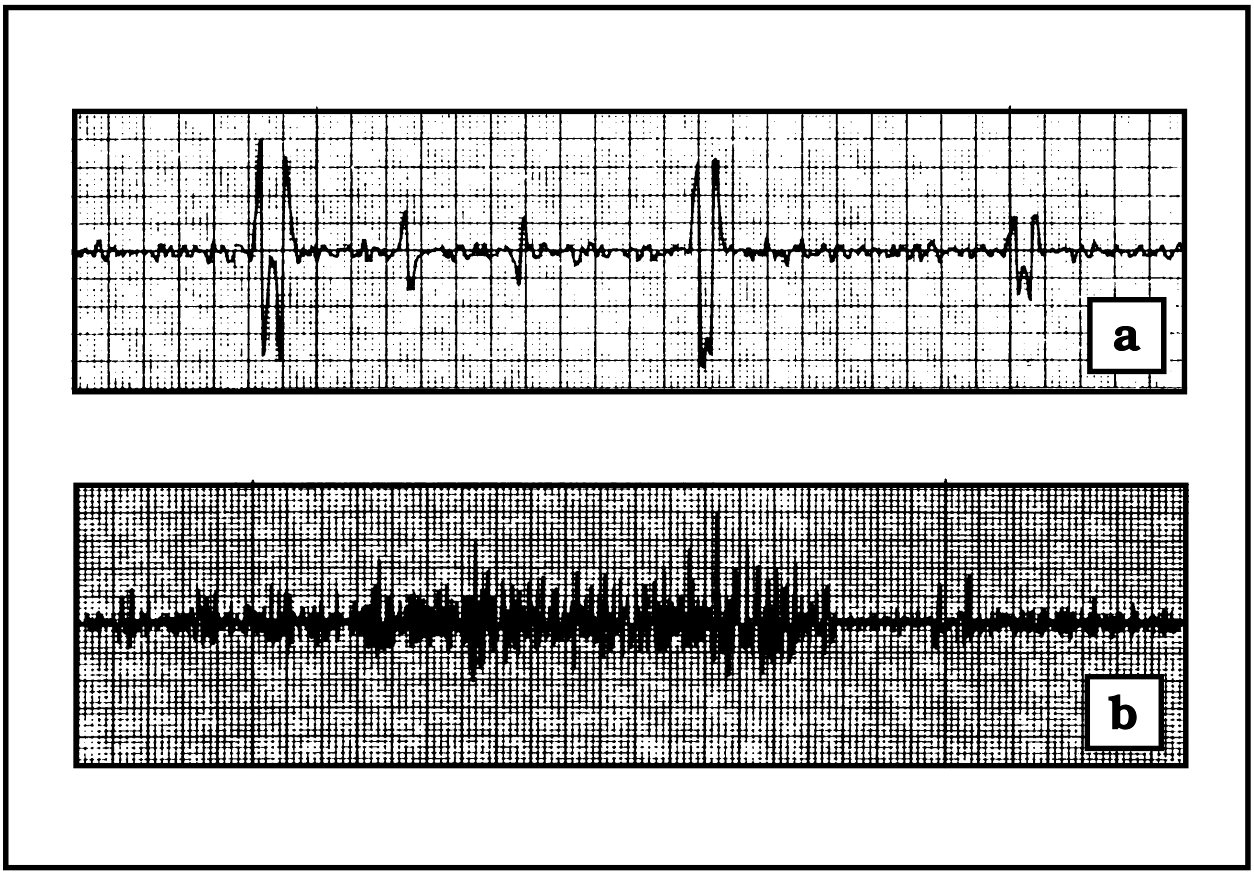


Fig. 15

CASAR®

SPECIAL WIRE ROPES

machine: ______ application: ______

type of rope: ______

nominal diameter [mm]: ______

tensile strength [N/mm^2]: ______

rope length [m]: ______

date of installation: ______

☐ left hand lay ☐ right hand lay

☐ regular lay ☐ langs lay

☐ ungalvanized ☐ galvanized

type of end fitting: ______

working hours to date: ______

location measured	no. of broken wires on 10 x d	abrasion	corrosion	diameter/ ø-reduction mm/%	other
	allowed no.:	*	*	eff. Ø of new rope	**

final evaluation	date/ signature

* description, e.g. no, little, etc.
** comments, e.g. description of a rope deformation

CASAR®

SPECIAL WIRE ROPES

Discard Number of Wire Breaks according to the criteria of BS 6570

CASAR

	rotation resistant	compacted strands	plastic infill	average fill factor	average weight factor	spin factor*	total number of wires	number of bearing wires in the outer strands**	factor of safety less than 5: discard number of wire breaks	factor of safety greater than 5: discard number of wire breaks
STARLIFT	●			0,653	0,90	0,77	245	112	4	8
EUROLIFT	●	●		0,748	0,86	0,79	280	126	4	8
POWERPLAST	●	●	●	0,710	0,91	0,84	358	126	4	22
STRATOPLAST			●	0,608	0,92	0,87	319	152	10	20
TURBOPLAST		●	●	0,661	0,87	0,86	327	208	10	20
SUPERPLAST		●	●	0,688	0,86	0,84	344	260	12	24
STRATOLIFT				0,660	0,89	0,86	303	152	10	20
TURBOLIFT		●		0,730	0,85	0,84	311	208	10	20
SUPERLIFT		●		0,755	0,85	0,84	307	205	10	20
ALPHALIFT				0,650	0,89	0,86	303	152	10	20
BETALIFT		●		0,755	0,85	0,84	307	205	10	20
UNILIFT				0,660	0,90	0,88	119	56	3	6
MEGALIFT				0,655	0,90	0,90	145	72	3	6
TECHNOLIFT				0,627	0,90	0,82	319	152	10	20
MULTILIFT		●		0,663	0,85	0,83	180	126	5	10
MULTILIFT F		●		0,566	0,90	0,86	126	126	5	10
RAMMBOLIFT	●			0,477	0,94	0,85	96	96	5	10
QUADROLIFT	○	●		0,684	0,86	0,84	140	140	7	14

* up to approx. 40 mm Ø, 1770 N/mm^2

** up to approx. 40 mm Ø

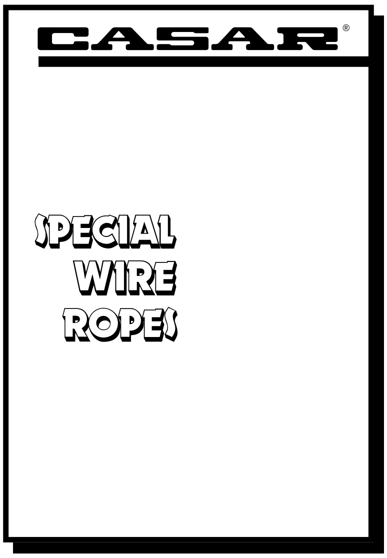
Additional CASAR literature

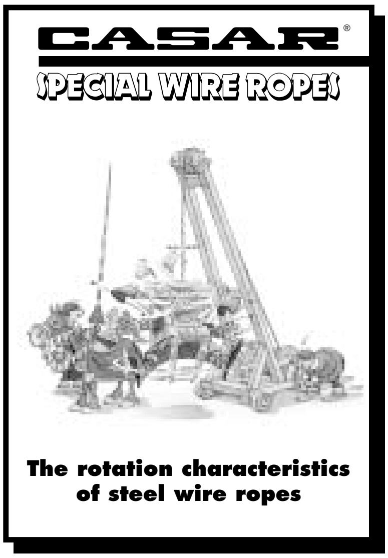
CASAR CD-ROM

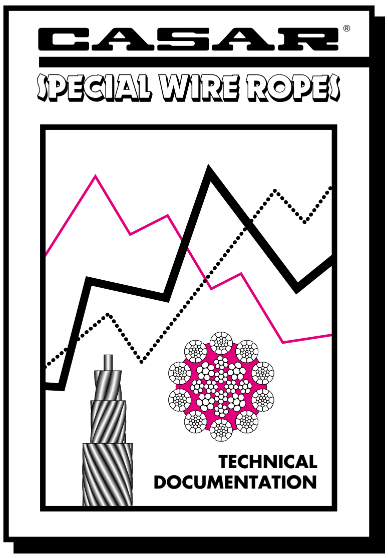
The first CASAR CD-ROM is an interactive tool with the intention to inform the user about wire ropes. It offers many detailed information referring to:

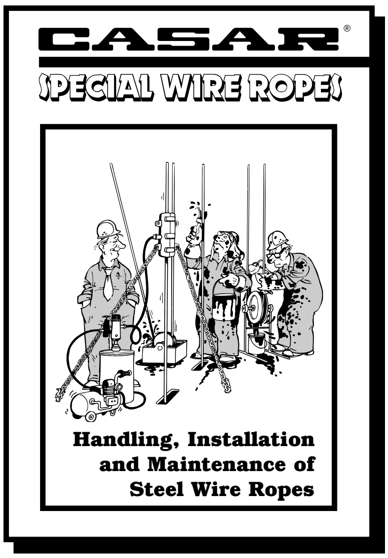
- technical features
- end connections
- handling
- installation
- maintenance
- inspection

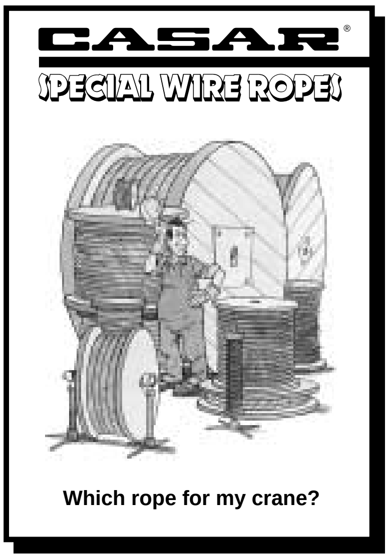
The CD-ROM is available at no cost.
For Macintosh and Windows.



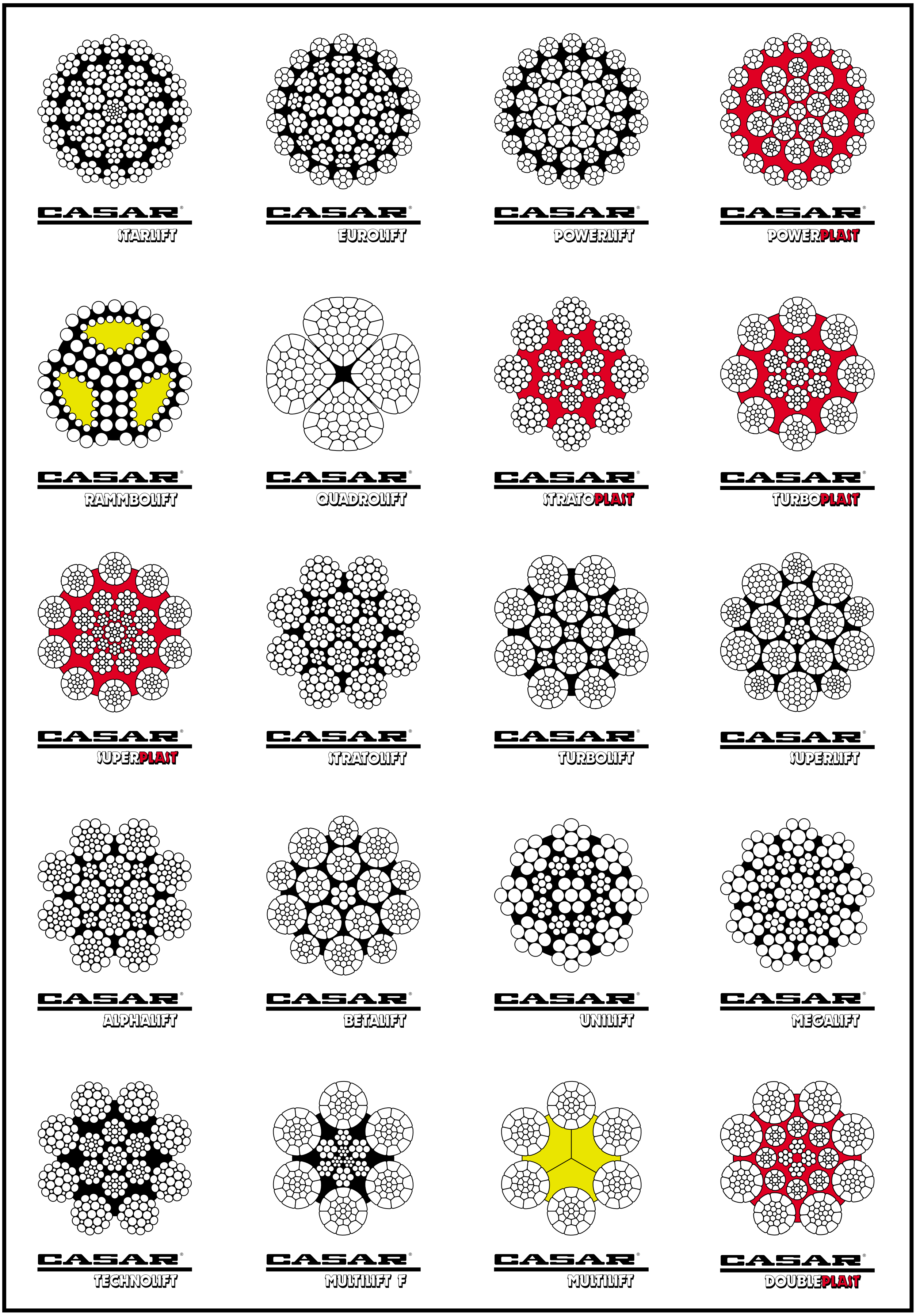








The CASAR product line



Nominal diameter	Metallic area	Weight	Calculated aggregate breaking load				Minimum breaking load			
			with tensile strength of wire							
			1770 N/mm² (180 kp/mm²)		1960 N/mm² (200 kp/mm²)		1770 N/mm² (180 kp/mm²)		1960 N/mm² (200 kp/mm²)	
mm	mm²	kg/%m	kN	t	kN	t	kN	t	kN	t
7	25,0	22,5	44,2	4,51	49,0	4,99	34,1	3,47	37,8	3,86
8	32,8	29,5	58,1	5,92	64,3	6,56	44,5	4,53	49,3	5,03
9	40,8	36,7	72,2	7,37	80,0	8,16	55,4	5,63	61,3	6,26
10	51,7	46,5	91,5	9,33	101,3	10,33	69,2	7,04	76,6	7,82
11	62,2	56,0	110,2	11,23	122,0	12,44	83,1	8,45	92,1	9,39
12	73,9	66,5	130,9	13,34	144,9	14,78	99,9	10,16	110,7	11,29
13	86,9	78,2	153,7	15,68	170,2	17,36	117,3	11,92	129,8	13,25
14	100,4	90,4	177,7	18,13	196,8	20,07	135,9	13,83	150,5	15,36
15	116,0	104,4	205,3	20,94	227,4	23,19	156,3	15,89	173,0	17,66
16	132,3	119,0	234,1	23,87	259,3	26,44	178,1	18,11	197,2	20,12
17	147,8	133,0	261,5	26,67	289,6	29,53	200,1	20,35	221,6	22,61
18	165,5	149,0	293,0	29,88	324,4	33,08	222,6	22,64	246,5	25,15
19	186,6	167,9	330,3	33,68	365,7	37,30	250,9	25,52	277,8	28,35
20	205,0	184,5	362,9	37,00	401,8	40,98	277,7	28,24	307,5	31,38
21	226,7	204,0	401,2	40,91	444,3	45,30	306,3	31,15	339,2	34,61
22	250,0	225,0	442,5	45,12	490,0	49,96	337,0	34,27	373,2	38,08
23	271,2	244,1	480,0	48,94	531,5	54,20	366,5	37,28	405,9	41,42
24	296,0	266,4	523,8	53,42	580,1	59,15	400,5	40,73	443,5	45,26
25	319,9	287,9	566,2	57,74	627,0	63,94	431,9	43,93	478,3	48,81
26	347,0	312,3	614,2	62,63	680,2	69,36	469,2	47,71	519,5	53,01
27	372,9	335,6	660,0	67,30	730,9	74,53	508,3	51,69	562,9	57,44
28	402,1	361,9	711,7	72,57	788,1	80,36	548,8	55,81	607,7	62,01
29	432,5	389,2	765,5	78,06	847,7	86,44	585,8	59,57	648,6	66,19
30	464,7	418,3	822,6	83,88	910,9	92,89	627,1	63,77	694,4	70,85
32	526,4	473,7	931,7	95,00	1031,7	105,20	710,5	72,25	786,7	80,28
34	591,2	532,1	1046,4	106,71	1158,8	118,16	803,9	81,75	890,2	90,84
36	661,5	595,3	1170,8	119,39	1296,5	132,21	906,1	92,15	1003,4	102,39
38	742,5	668,3	1314,2	134,01	1455,3	148,40	1005,5	102,26	1113,5	113,62
40	818,1	736,3	1448,0	147,66	1603,5	163,51	1111,9	113,08	1231,3	125,64
42	902,7	812,4	1597,8	162,93	1769,3	180,42	1234,1	125,50	1366,6	139,44
44	994,4	895,0	1760,1	179,48	1949,1	198,75	1352,7	137,56	1497,9	152,85
46	1083,6	975,3	1918,0	195,58	2123,9	216,58	1473,9	149,89	1632,1	166,54
48	1186,5	1067,8	2100,1	214,15	2325,5	237,14	1608,1	163,53	1780,7	181,70
50	1286,3	1157,7	2276,8	232,17	2521,2	257,09	1740,0	176,94	1926,7	196,61
52	1391,7	1252,5	2463,3	251,18	2727,7	278,15	1832,5	186,35	2029,2	207,06
54	1501,4	1351,2	2657,4	270,98	2942,7	300,07	1976,4	200,99	2188,5	223,32
56	1610,3	1449,3	2850,3	290,65	3156,3	321,85	2141,3	217,76	2371,1	241,95
58	1727,4	1554,7	3057,5	311,78	3385,7	345,25	2285,4	232,42	2530,8	258,24
60	1848,6	1663,7	3272,0	333,65	3623,3	369,47	2455,9	249,75	2719,5	277,50
62	1973,9	1776,5	3493,8	356,27	3868,8	394,51	2623,1	266,76	2904,7	296,40
64	2103,3	1893,0	3722,8	379,62	4122,5	420,37	2799,3	284,67	3099,8	316,31
66	2236,8	2013,1	3959,1	403,72	4384,1	447,06	2978,8	302,93	3298,5	336,59
68	2374,4	2137,0	4202,7	428,56	4653,9	474,56	3173,9	322,77	3514,6	358,64
70	2516,2	2264,5	4453,6	454,14	4931,7	502,89	3336,5	339,31	3694,7	377,01
72	2662,0	2395,8	4711,7	480,46	5217,5	532,04	3545,6	360,57	3926,2	400,64

CASAR® EUROLIFT

Nominal diameter	Metallic area	Weight	Calculated aggregate breaking load						Minimum breaking load					
			with tensile strength of wire											
			1770 N/mm^2 (180 kp/mm^2)		1960 N/mm^2 (200 kp/mm^2)		2160 N/mm^2 (220 kp/mm^2)		1770 N/mm^2 (180 kp/mm^2)		1960 N/mm^2 (200 kp/mm^2)		2160 N/mm^2 (220 kp/mm^2)	
mm	mm^2	kg/%m	kN	t	kN	t	kN	t	kN	t	kN	t	kN	t
10	56,9	49,0	100,8	10,28	111,6	11,38	123,0	12,54	81,9	8,33	89,6	9,14	97,4	9,86
11	69,0	59,3	122,1	12,45	135,2	13,79	149,0	15,19	99,5	10,12	108,8	11,11	118,4	11,98
12	82,0	70,5	145,1	14,79	160,7	16,38	177,0	18,05	118,2	12,10	130,8	13,30	139,9	14,16
13	95,4	82,1	168,9	17,22	187,0	19,07	206,1	21,02	139,0	14,14	152,7	15,60	165,4	16,73
14	110,4	94,9	195,4	19,93	216,4	22,06	238,5	24,32	161,7	16,50	179,1	18,30	190,9	19,31
15	126,8	109,1	224,5	22,89	248,6	25,35	274,0	27,94	184,5	18,80	204,0	20,80	219,5	22,21
16	146,2	125,7	258,8	26,39	286,6	29,22	315,8	32,20	209,4	21,29	230,6	23,50	249,1	25,20
17	163,5	140,6	289,4	29,51	320,5	32,68	353,2	36,02	235,9	23,99	257,9	26,32	280,6	28,39
18	186,2	160,1	329,5	33,60	364,9	37,21	402,1	41,01	266,9	27,15	293,9	30,00	317,5	32,13
19	205,6	176,8	363,8	37,10	402,9	41,08	444,0	45,28	297,1	30,30	329,0	33,50	352,8	35,70
20	227,5	195,6	402,6	41,06	445,9	45,47	491,4	50,11	329,3	33,49	362,2	36,90	391,7	39,64
21	249,1	214,2	440,9	44,96	488,3	49,79	538,1	54,87	362,3	36,84	396,1	40,20	430,9	43,60
22	276,0	237,3	488,5	49,81	540,9	55,16	596,1	60,78	398,5	40,60	441,4	45,00	472,0	47,76
23	303,3	260,9	536,9	54,75	594,5	60,62	655,2	66,81	431,5	43,88	471,8	48,14	513,2	51,94
24	327,1	281,3	578,9	59,03	641,1	65,37	706,5	72,04	474,3	48,30	524,3	53,50	564,1	57,08
25	357,6	307,6	633,0	64,55	701,0	71,48	772,5	78,78	512,8	52,30	567,9	57,90	609,4	61,67
26	382,0	328,5	676,1	68,94	748,6	76,34	825,0	84,13	555,0	56,60	614,9	62,70	657,4	66,52
27	410,5	353,0	726,5	74,08	804,5	82,03	886,6	90,41	598,3	60,85	654,2	66,75	711,7	72,02
28	447,3	384,6	791,7	80,73	876,6	89,39	966,1	98,51	643,7	65,60	712,9	72,70	765,6	77,47
29	472,3	406,2	835,9	85,24	925,7	94,39	1020,1	104,02	690,2	70,19	754,6	77,00	821,0	83,07
30	505,4	434,7	894,6	91,23	990,6	101,02	1091,7	111,33	738,1	75,30	817,4	83,40	877,9	88,84
32	582,7	501,1	1031,3	105,16	1142,0	116,45	1258,5	128,33	843,4	85,74	930,0	94,90	1002,8	101,48
34	655,9	564,0	1160,9	118,38	1285,5	131,08	1416,7	144,46	950,8	96,69	1045,0	106,60	1130.9	114,44
36	735,7	632,7	1302,1	132,78	1441,9	147,03	1589,0	162,04	1070,0	109,10	1185,0	120,90	1262,3	127,74
38	823,3	708,1	1457,3	148,60	1613,7	164,55	1778,4	181,34	1191,0	121,50	1319,0	134,50	1412,2	142,90
40	910,5	783,1	1611,7	164,34	1784,7	181,98	1966,8	200,55	1360,0	138,00	1462,0	149,10	1560,4	157,90
42	1004,2	863,6	1777,5	181,25	1968,3	200,71	2169,1	221,19	1455,0	147,97	1611,2	164,41	1667,4	169,83
44	1098,4	944,6	1944,1	198,24	2152,8	219,53	2372,5	241,93	1596,0	162,80	1767,0	180,20	1823,7	185,75
46	1198,3	1030,6	2121,0	216,29	2348,7	239,50	2588,4	263,94	1748,0	178,30	1935,0	197,40	1989,7	202,65
48	1317,2	1132,7	2331,4	237,73	2581,6	263,25	2845,0	290,11	1908,4	194,30	2113,3	215,64	2187,0	222,75

Further diameters upon request.

CASAR® STRATOPLAST

Nominal diameter	Metallic area	Weight	Calculated aggregate breaking load				Minimum breaking load			
			with tensile strength of wire							
			1770 N/mm² (180 kp/mm²)		1960 N/mm² (200 kp/mm²)		1770 N/mm² (180 kp/mm²)		1960 N/mm² (200 kp/mm²)	
mm	mm²	kg/%m	kN	t	kN	t	kN	t	kN	t
8	30,8	28,3	54,5	5,56	60,3	6,15	47,2	4,80	52,3	5,34
9	39,5	36,3	69,9	7,12	77,4	7,89	60,0	6,10	66,4	6,78
10	48,3	44,4	85,4	8,71	94,6	9,65	74,0	7,53	82,0	8,37
11	60,0	55,2	106,3	10,84	117,7	12,00	88,5	9,00	98,0	10,00
12	69,9	64,3	123,7	12,62	137,0	13,97	106,6	10,84	118,0	12,05
13	81,1	74,6	143,6	14,64	159,0	16,22	125,5	12,76	138,9	14,18
14	93,9	86,4	166,2	16,95	184,1	18,77	144,6	14,71	160,1	16,34
15	109,4	100,7	193,7	19,75	214,5	21,87	166,3	16,91	184,1	18,79
16	123,9	114,0	219,3	22,37	242,9	24,77	189,0	19,22	209,3	21,36
17	139,5	128,4	247,0	25,18	273,5	27,89	211,5	21,51	234,2	23,90
18	156,1	143,7	276,4	28,18	306,0	31,21	239,8	24,38	265,5	27,09
19	177,5	163,3	314,2	32,04	347,9	35,48	264,5	26,90	292,9	29,89
20	195,8	180,2	346,6	35,34	383,8	39,14	295,3	30,03	327,0	33,36
21	217,3	199,9	384,6	39,22	425,9	43,43	324,2	32,97	359,0	36,63
22	237,6	218,6	420,6	42,89	465,7	47,49	356,2	36,23	394,5	40,25
23	258,6	237,9	457,6	46,67	506,8	51,68	386,8	39,34	428,3	43,71
24	280,3	257,9	496,1	50,59	549,4	56,02	423,4	43,06	468,9	47,84
25	302,0	277,8	534,5	54,51	591,9	60,36	464,3	47,22	514,2	52,47
26	326,8	300,6	578,4	58,98	640,4	65,31	504,7	51,32	558,8	57,03
27	353,2	324,9	625,1	63,75	692,2	70,59	535,8	54,49	593,3	60,54
28	375,9	345,8	665,3	67,84	736,7	75,12	576,2	58,59	638,0	65,10
29	407,7	375,1	721,6	73,59	799,1	81,48	618,0	62,85	684,3	69,83
30	435,8	400,9	771,4	78,66	854,2	87,10	666,3	67,76	737,8	75,28
31	464,3	427,1	821,8	83,80	910,0	92,79	708,3	72,03	784,3	80,03
32	495,4	455,8	876,9	89,42	971,1	99,02	756,7	76,95	837,9	85,50
33	526,4	484,3	931,7	95,01	1031,7	105,21	809,6	82,33	896,5	91,48
34	556,8	512,3	985,5	100,50	1091,3	111,29	853,7	86,82	945,3	96,46
35	585,9	539,1	1037,1	105,76	1148,4	117,11	905,8	92,12	1003,0	102,35
36	626,5	576,4	1108,9	113,08	1227,9	125,21	952,4	96,86	1054,7	107,62
38	705,1	648,7	1248,0	127,26	1382,0	140,92	1071,1	108,92	1186,0	121,02
40	779,4	717,0	1379,5	140,67	1527,6	155,77	1181,1	120,11	1307,9	133,46
42	859,3	790,6	1521,0	155,10	1684,3	171,75	1308,5	133,06	1448,9	147,85
44	942,5	867,1	1668,2	170,11	1847,3	188,37	1430,1	145,44	1583,7	1691,60
46	1031,5	949,0	1825,8	186,18	2021,8	206,17	1556,7	158,31	1723,8	175,90
48	1123,1	1033,3	1987,9	202,71	2201,3	224,47	1692,8	172,15	1874,5	191,27
50	1212,7	1115,7	2146,5	218,88	2376,9	242,38	1850,7	188,21	2049,4	209,12
52	1309,7	1204,9	2318,2	236,39	2567,0	261,76	2013,7	204,78	2229,9	227,54
54	1410,5	1297,7	2496,7	254,59	2764,7	281,92	2175,3	221,22	2408,8	245,80
56	1508,1	1387,4	2669,3	272,19	2955,9	301,41	2344,8	238,45	2596,5	264,94
58	1581,2	1454,7	2798,7	285,39	3099,1	316,02	2508,9	255,14	2778,2	283,49
60	1707,4	1570,8	3022,1	308,17	3346,5	341,25	2621,5	266,59	2902,9	296,21
62	1845,1	1697,5	3265,9	333,03	3616,4	368,77	2815,8	286,35	3118,0	318,17
64	1966,1	1808,8	3480,0	354,86	3853,5	392,95	3000,1	305,10	3322,1	338,99
66	2090,9	1923,6	3700,9	377,38	4098,1	417,89	3198,3	325,25	3541,6	361,39
68	2183,5	2008,8	3864,8	394,10	4279,6	436,40	3357,6	341,45	3718,0	379,39
70	2352,0	2163,8	4163,0	424,51	4609,9	470,08	3552,7	361,29	3934,1	401,44
72	2488,3	2289,3	4404,3	449,12	4877,1	497,33	3751,7	381,53	4154,4	423,92

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Readers Comments

For reasons of space, this booklet can only deal with general aspects of wire rope inspection and examination. However, the publisher and the authors are always pleased to give their opinions on specific problems.

For future editions of this booklet, the authors look forward to receiving readers' suggestions for improvements or general comments.

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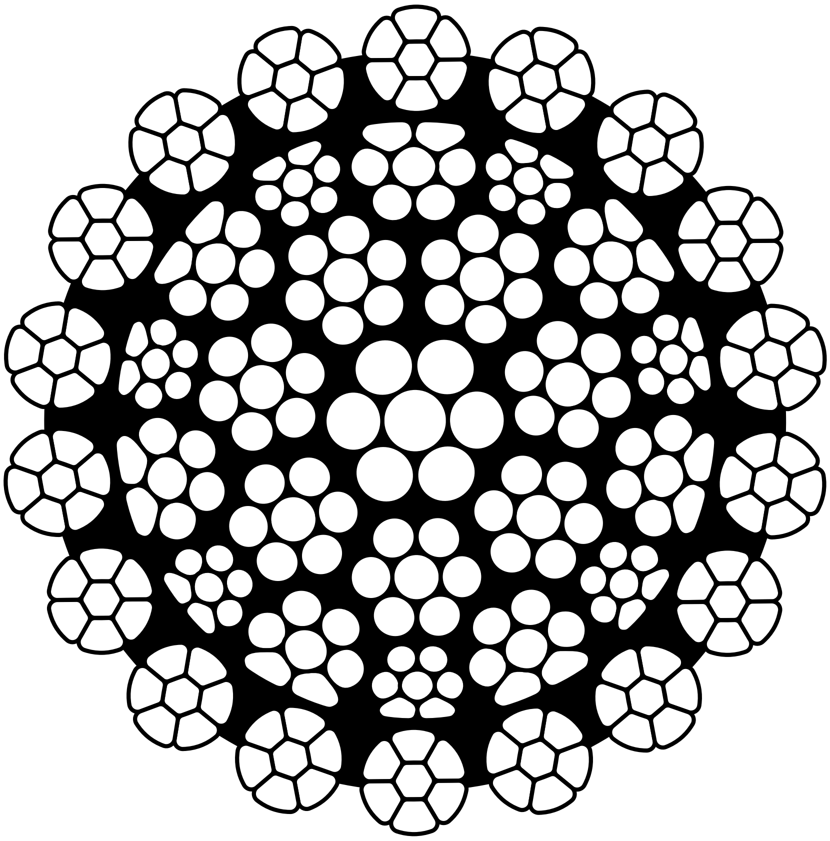

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