INTERNATIONAL STANDARD

ISO 4309

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Cranes — Wire ropes — Care, maintenance, installation, examination and discard

Appareils de levage à charge suspendue — Câbles — Entretien, maintenance, installation, examen et dépose

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 4309 was prepared by Technical Committee ISO/TC 96, *Cranes*, Subcommittee SC 3, *Selection of wire ropes*.

This third edition cancels and replaces the second edition (ISO 4309:1990), which has been technically revised.

Introduction

The rope on a crane is regarded as an expendable component, requiring replacement when examination shows its strength to have diminished to the point where its further use would be unwise.

The working life of the rope varies in relation to the particular characteristics of the crane, its conditions and use. Where long rope life is essential, a high coefficient of utilization and high bending ratio (D/d) are adopted. Where lightness and compactness of design are essential, these values can be reduced, provided that a smaller number of operating cycles is acceptable.

In all cases the safe handling of loads by a correctly operated crane depends upon regular examination of the rope, so that the rope can be removed from service before problems arise.

Certain cranes function in conditions where the ropes are exposed to accidental damage, and the original rope selection would have taken this into account. In such circumstances, examination of the rope needs to be carried out with care to ensure that any critical condition of damage can be recognized and the rope can be immediately removed from service.

In all conditions of use, the discard criteria relating to wire breaks, wear, corrosion and deformation can be applied immediately. These different factors are considered in this International Standard, which is intended to provide guidance for competent persons involved in the maintenance and examination of cranes.

The criteria outlined are aimed at retaining, until the rope is discarded, an adequate safety margin for the handling of loads by cranes. Failure to recognize these criteria is dangerous.

This International Standard now includes recommendations in respect of the care and maintenance, including fitting, of the rope. These additions have been made to ensure that the user and competent persons responsible for the crane have one single guidance document covering all aspects, from receipt of the new rope through to the discard of the rope from service on the crane.

The classification groups of the mechanisms referred to in this International Standard are in accordance with ISO 4301-1.

Cranes — Wire ropes — Care, maintenance, installation, examination and discard

1 Scope

This International Standard details guidelines for the care, installation, maintenance and examination of wire rope in service on a crane, and enumerates the discard criteria to be applied to promote the safe use of the crane.

This International Standard is applicable to the following types of crane, as defined in ISO 4306-1:

a) cable and portal cable cranes;

b) cantilever cranes (pillar jib, wall or walking);

c) deck cranes;

d) derrick and guy derrick cranes;

e) derrick cranes with rigid bracing;

f) floating cranes;

g) mobile cranes;

h) overhead travelling cranes;

i) portal or semi-portal bridge cranes;

j) portal or semi-portal cranes;

k) railway cranes;

l) tower cranes.

This International Standard is applicable to cranes used for hook, grabbing, magnet, ladle, excavator or stacking duties, whether operated manually, mechanically, electrically or hydraulically.

This International Standard is also applicable to hoists and hoist blocks which use wire rope.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
actual rope diameter
average of two measurements of the diameter of the rope, made normal to each other

NOTE It is expressed in millimetres.

2.2
clearance
space between individual wires in any layer in a wire rope strand or between any strands in the same layer

2.3
cross-over
⟨of rope on a drum⟩ portion of wire rope which changes from its normal path as it moves from one lap or layer to another lap or layer, due to the effect of either the type of drum grooving or the configuration of the underlying rope layer

2.4
Lang lay
lay in which the direction of lay of the wires in the outer strands is in the same direction as that of the outer strands in the rope

2.5
wrap
one revolution of rope around a drum

2.6
lay length
distance, measured parallel to the longitudinal rope axis, required for the outer wire of a spiral rope and the outer strands of a stranded rope to make one complete turn (or helix) about the axis of the rope

2.7
nominal rope diameter
designated diameter of the rope

NOTE It is expressed in millimetres.

2.8
ordinary lay
regular lay
lay in which the direction of lay in the outer wires in the outer strands is in the opposite direction to that of the outer strands in the rope

2.9
reel
flanged spool on which rope is wound for shipment or storage

NOTE A reel can be of wooden or steel construction, depending on the mass of rope involved.

2.10
rope core
central element of the rope that supports outer strands

2.11
rope examination record
record of the history and condition of the rope following an examination

2.12
single-layer rope
stranded rope consisting of one layer of strands laid helically over a core

2.13
parallel-closed rope
stranded rope consisting of at least two layers of strands laid helically in one closing operation around a strand or fibre centre

2.14
rotation-resistant rope
stranded rope designed to generate reduced levels of torque and rotation when loaded

NOTE 1 Rotation-resistant ropes generally comprise an assembly of two or more layers of strands laid helically around a centre, the direction of lay of the outer strands being opposite to that of the underlying layer.

NOTE 2 Ropes having three or four strands can also be designed to exhibit rotation-resistant properties.

NOTE 3 Rotation-resistant ropes have previously been referred to as contra-laid, multi-strand and non-rotating ropes.

2.15
stranded rope
assembly of several strands laid helically in one or more layers usually around a core or centre

NOTE Stranded ropes consisting of three or four outer strands may not have a core.

3 Wire rope

3.1 Condition before installation

3.1.1 Rope replacement

Only a rope of the correct length, diameter, construction and breaking force as specified by the crane manufacturer shall be installed on the crane, unless an alternative rope has been approved by the crane designer, rope manufacturer or other competent person.

Only rope terminations specified by the crane manufacturer, or alternatives similarly approved, shall be used to attach a rope to a drum, hook block or crane structure.

3.1.2 Rope length

The length of rope used shall be sufficient for the application for which the crane is to be used, and shall be such that in the extreme positions there are at least two wraps of rope left on the drum.

When the length of rope required for use is to be cut from a longer length, servings shall be made on both sides of the cutting point, or a suitable technique shall be used to prevent the rope from untwisting when the cut is made (see Figure 1).

3.1.3 Instructions from the crane manufacturer and the rope manufacturer

The instructions in the crane manual and those given by the rope manufacturer shall be followed.

Before re-equipping the crane, all grooves in drums and sheaves shall be checked to ensure that they will correctly accept the replacement rope (see Clause 5).

3.1.4 Offloading and storage

To avoid accidents, ropes shall be offloaded with care. The rope reels or coils shall not be dropped, neither shall the rope be struck by a metal hook or fork of a fork-lift truck.

Ropes shall be stored in a cool, dry building and shall not be in contact with the floor. Ropes shall never be stored where they are liable to be affected by chemical fumes, steam or other corrosive agents. Ropes in storage shall be examined periodically and if necessary, a rope dressing applied. If outdoor storage cannot be avoided, the ropes should be covered so that moisture cannot induce corrosion.

Ropes removed from a crane for future use shall be thoroughly cleaned and a rope dressing applied before being stored.

Ropes having a length in excess of 30 m should be stored on reels.

3.2 Installation

3.2.1 Uncoiling and installing

When uncoiling the wire rope from a reel or coil, every precaution shall be taken to avoid the inducement of turn into, or loss of turn out of, the rope. Allowing such a condition can result in formation of loops, kinks or bends in the rope. To prevent this condition, the rope shall be paid out without slack and in a straight line (see Figure 2).

A revolving reel of rope can have a high inertia, in which case it needs to be controlled in order to slowly pay out the rope.

Rope in coil should be paid out from a turntable. Alternatively, where a coil is of short length, the outer end of the coil may be made free and the remainder rolled along the ground (see Figure 3). For ease of handling, the inside end shall first be secured to an adjacent wrap. A rope shall never be paid out by throwing off wraps with the coil or reel flat on the ground (see Figure 4).

The rope shall be kept as clean as possible during uncoiling. When any rope is cut, the manufacturer's instructions shall be followed (see Figure 1).

Particular care shall be taken with rotation-resistant ropes to ensure that they are installed without inducing or losing turn, and that any cut is secured and prevented from unlaying.

NOTE 1 If the strands are disturbed, deformation of the rope is likely to occur during subsequent use and the service life of the rope may be reduced.

NOTE 2 Introducing or losing turn during installation can result in additional twisting of the hook block.

The lay of the rope shall not be disturbed during installation, i.e. turn should not be put in nor taken out of the rope. During installation, the rope shall always bend in the same direction: i.e. pay out from the top of the reel to the top of the drum, or from the bottom of the reel to the bottom of the drum (see Figure 2).

Care shall be taken to ensure that termination anchorages are made and secured in accordance with the instructions in the crane manual.

If the rope rubs against any part of the crane during installation, then the points of contact shall be suitably protected.

3.2.2 Running in

Before bringing the rope into operation on the crane, the user shall ensure that all the devices associated with the wire rope operation are functioning correctly. A number of operational cycles of the mechanism shall be carried out at reduced speed and load, up to approximately 10 % of the Working Load Limit (WLL) to allow the component parts of the rope to adjust to the actual operating conditions.

3.3 Maintenance

Maintenance of the wire rope shall be carried out relative to the crane, its use, the environment and the type of rope involved. Unless otherwise indicated by the manufacturer of either the crane or the rope, a rope dressing of grease or oil shall be applied during installation. Subsequently the wire rope shall be cleaned where necessary, and the rope dressing re-applied at regular intervals and before the rope shows signs of dryness or corrosion, particularly on the lengths which pass over sheaves.

The rope dressing shall be compatible with the original lubricant used by the wire rope manufacturer, and shall have penetrating characteristics. If the rope dressing is not identified in the crane manual, the user shall seek advice from the rope manufacturer.

A shorter working life of the rope will result from lack of maintenance, particularly if the crane is used in a corrosive environment and, in certain cases for reasons connected with the operation, if no rope dressing can be used. In such cases the period between rope examinations shall be reduced accordingly.

3.4 Examination

3.4.1 Frequency

3.4.1.1 Daily visual inspection

As far as possible, all visible parts of any rope shall be observed each working day with the objective of detecting general deterioration and deformation. Particular attention shall be paid to the rope at points of attachment to the crane (see Figure A.1). Any appreciable change suspected in the rope condition shall be reported, and the rope examined by a competent person in accordance with 3.4.2.

3.4.1.2 Periodic examination

Periodic examination shall be carried out by competent persons in accordance with 3.4.2.

In order to determine the frequency of a periodic examination, consideration shall be given to

a) the statutory requirements covering the application in the country of use,

b) the type of crane and the environmental conditions in which it operates,

c) the classification group of the crane,

d) the results of previous examination,

e) the length of time the rope has been in service.

Mobile crane ropes and tower crane ropes should be examined at least once per month or more often, in accordance with the instructions of the competent person.

NOTE Depending on the condition of the rope, the competent person may deem it necessary to reduce the time interval between examinations.

3.4.1.3 Special examination

Special examination shall be carried out in accordance with 3.4.2.

The rope shall be examined if an incident has occurred which could have caused damage to the rope and/or its termination, or if a rope has been brought back into operation after dismantling followed by re-assembly.

If the crane has been out of operation for three months or more, the ropes should be examined prior to recommencement of work.

NOTE Depending on the condition of the rope, the competent person may deem it necessary to reduce the time interval between examinations.

3.4.1.4 Inspection of ropes operating on synthetic sheaves or metal sheaves having synthetic lining

If a rope operates either solely or partially over synthetic sheaves or over metal sheaves having a synthetic lining, wire breaks can occur internally in large numbers before there is any external visible evidence of wire breaks or of substantial wear on the periphery of the rope. In these conditions, consideration shall be given to the establishment of a specific inspection schedule period based on past rope performance data, taking into account the results from regular inspection in service and information gained from detailed examination of ropes following retirement from service.

Particular attention shall be paid to any localized area which exhibits a dryness or denaturing of the lubricant.

Information for the criteria for discard of wire rope for specific lifting appliances shall be based on an exchange of information between the crane manufacturer and the wire rope manufacturer.

NOTE Depending on the condition of the rope, the competent person may deem it necessary to reduce the time interval between examinations.

3.4.2 Points to be covered by examination

3.4.2.1 General

Although the wire rope shall be examined throughout its length, particular care shall be taken at the following locations:

a) the termination points of both moving and stationary ropes;

b) that part of the rope which passes through the block or over sheaves;

c) in the case of cranes performing a repetitive operation, any part of the rope which lies over sheave(s) while the crane is in a loaded condition (see Annex A);

d) that part of the rope which lies over a compensating sheave;

e) any part of the rope which may be subject to abrasion by external features (e.g. hatch coamings);

f) internals of the rope, for corrosion and fatigue (see Annex C);

g) any part of the rope exposed to heat.

The results of the examination shall be recorded in the examination record for the crane (see Clause 6 and Annex B for a typical example).

3.4.2.2 Terminations, excluding slings

The rope shall be examined in the area where it passes out from the termination, as this position is critical for the onset of fatigue (wire breaks) and corrosion. The terminal fittings themselves shall also be examined for signs of distortion or wear.

Terminations involving pressed or swaged ferrules shall be similarly examined, and the ferrule checked for cracks in the material and possible slippage between the ferrule and the rope.

Detachable terminations (e.g. wedge sockets, grips) shall be examined for broken wires within and under the termination, and for tightness of wedges and screwed grips. The examination should also include an assessment that the standards and codes of practice specified for the termination of the rope have been met.

Eye splices made by hand shall be examined to check that they are served only over the tail of the splice (so as to protect the hands from protruding wire), while at all times allowing the remainder of the splice to be visually inspected for wire breaks.

When broken wires are evident close to, or within, the termination, it may be possible to shorten the rope and re-fit the terminal fittings. However, the resulting length of the wire rope shall be sufficient to allow for the minimum required number of rope wraps on the drum.

3.4.3 Non-destructive testing

Non-destructive testing by electromagnetic techniques may be used as an aid to visual inspection to determine areas and levels of rope deterioration.

When it is the intention to use electromagnetic means of NDT as an aid to visual examination, the rope should be subject to an initial electromagnetic NDT examination as soon as possible after the rope has been installed.

3.5 Discard criteria

3.5.1 General

The safe use of wire rope is qualified by the following criteria (see 3.5.2 to 3.5.12):

a) the nature and number of broken wires;

b) broken wires at the termination;

c) localized grouping of wire breaks;

d) the rate of increase of wire breaks;

e) the fracture of strands;

f) reduction of rope diameter, including that resulting from core deterioration;

g) decreased elasticity;

h) external and internal wear;

i) external and internal corrosion;

j) deformation;

k) damage due to heat or electric arcing;

l) rate of increase of permanent elongation.

All examinations shall take into account these individual factors, recognizing the particular criteria. However, deterioration frequently results from a combination of factors, giving a cumulative effect which should be recognized by the competent person, and which reflects the decision to discard the rope or to allow it to remain in service.

In all cases, the examiner shall investigate whether the deterioration has been caused by an abnormality in the crane; if so, he should recommend action to overcome that abnormality before installing a new rope.

The individual degrees of deterioration should be assessed, and expressed as a percentage of the particular discard criteria. The cumulative degree of deterioration at any given position is determined by adding together the individual values that are recorded at that position in the rope. When the cumulative value at any position reaches 100 %, the rope should be discarded.

3.5.2 Nature and number of broken wires

The overall design of a crane is such that it does not permit indefinite rope life. In the case of 6- and 8-strand ropes, broken wires usually occur at the external surface. In the case of rotation-resistant ropes, there is a probability that the majority of broken wires will occur internally and are “non-visible” fractures. Tables 1 and 2 take these factors into account when considered in conjunction with the factors given in 3.5.3 to 3.5.12.

One valley break may indicate internal rope deterioration, requiring closer inspection of this section of rope. When two or more valley breaks are found in one lay length, the rope should be considered for discard.

When establishing rejection criteria for rotation-resistant ropes, consideration shall be given to the rope construction, length of service and the way in which the rope is being used. Guidance relating the number of visible broken wires and their rejection is given in Table 2.

Particular attention shall be paid to any localized area which exhibits a dryness or denaturing of the lubrication.

