International Standard 4308

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Cranes — Selection of wire ropes

Appareils de levage — Choix des câbles

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4308 was developed by Technical Committee ISO/TC 96, *Cranes, lifting appliances and related equipment*, and was circulated to the member bodies in February 1978.

It has been approved by the member bodies of the following countries :

Australia	Italy	South Africa, Rep. of
Czechoslovakia	Japan	Spain
Finland	Korea, Rep. of	Sweden
France	Mexico	Switzerland
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Belgium
Netherlands
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Cranes — Selection of wire ropes

1 Scope and field of application

This International Standard specifies two methods for the selection of wire rope to be used on the type of lifting appliances designated in ISO 4306, and which are listed in annex A.

This International Standard establishes the minimum requirements for these wire ropes in order that they may have acceptable strength and performance levels with respect to design, application and maintenance of the appliance.

It allows the wire rope to be selected by one of two methods, one based on the value of the rope selection factor C, and the other based on the value of the coefficient of utilisation Z_p, as given in table 1.

For the specific application to a type of apparatus (mobile cranes, travelling bridges, etc.), a choice in the classification groups shall be made in accordance with ISO 4301. Only the C or Z_p values of the selected group (or their calculated equivalent) shall be used for the choice of rope.

An example of such a choice is given in annex C for mobile cranes.

2 References

ISO 2408, *Steel wire ropes for general purposes — Characteristics.*

ISO 4301, *Lifting appliances — Classification.*

ISO 4306/1, *Lifting appliances — Vocabulary — Part 1 : Types of cranes.*[1]

ISO 4309, *Wire rope for lifting appliances — Code of practice for examination and discard.*

3 Type of rope

Where possible, the wire rope used shall be in accordance with ISO 2408.

However, the use of wire rope not specified by ISO 2408 is permitted, but in such cases the supplier of the wire rope shall show to the user that the product fulfils the minimum requirements detailed in this International Standard.

4 Duty conditions

The mechanisms of lifting appliances shall be classified according to the duty conditions laid down in ISO 4301.

5 Selection procedure

5.1 Calculation of C values

The value of C is a function of Z_p and is given by the equation

$$C = \sqrt{\frac{Z_p}{K' \times R_o}} \qquad \ldots(1)$$

where

C is the rope selection factor (minimum);

K' is the empirical factor of minimum breaking load of a given rope construction (see table 4 of ISO 2408);

R_o is the minimum tensile strength of the wire used in the rope, in newtons per square millimetre[2];

Z_p is the minimum practical coefficient of utilisation.

Table 1 gives the values of Z_p which shall be used for each classification group of mechanism in order to achieve the

1) At present at the stage of draft.

2) 1 N/mm^2 = 10^6 N/m^2 = 1 MPa

minimal requirements of this International Standard. It also gives the calculated values of C corresponding, as an example, to a rope with a tensile strength R_o of 1 570 N/mm^2 and with an empirical factor $K' = 0{,}294\ 8$.

Table 1 — C and Z_p values

Classification of mechanism	C value $\frac{\text{mm}}{\sqrt{\text{N}}}$	Z_p value
M.1	0,085	3,15
M.2	0,087	3,35
M.3	0,090	3,55
M.4	0,095	4,0
M.5	0,100	4,5
M.6	0,112	5,6
M.7	0,125	7,1
M.8	0,140	9,0

NOTE — Whilst equation (1) shows the exact relationship between C and Z_p, the values shown in table 1 have been corrected to follow numbers extracted from the Renard Series.

For ropes having a tensile strength R_o and an empirical factor K' different from those shown above, different values of C may be calculated using equation (1) and substituted in the equation (2) indicated in 5.1.1.

5.1.1 The minimum diameter of the rope, d, in millimetres, is given by the equation

$$d = C\sqrt{S} \qquad \ldots(2)$$

where

C is the rope selection factor;

S is the maximum rope tension, in newtons, which is obtained by taking account of the following factors :

a) rated working load of the appliance;

b) weight of the pulley block and/or other lifting attachments;

c) mechanical advantage of reeving;

d) efficiency of the rope reeving;

e) the weight of the suspended length of the hoist rope shall be included when the load handled is more than 5 m below the slewing mechanism of the lifting appliance.

5.1.2 The minimum breaking load, F_o, in newtons, of the particular rope intended for use is given by the equation

$$F_o = S \times Z_p \qquad \ldots(3)$$

where

S is the maximum rope tension, in newtons, as defined in 5.1.1;

Z_p is the minimum practical coefficient of utilisation.

Examples of rope selection are given in annex B.

6 Diameter of rope drum and pulleys

The minimum pitch diameter of the rope drums, rope pulleys and compensating pulleys shall be calculated using the minimum rope diameter established in 5.1 and by applying the respective values of h_1, h_2, and h_3, as applicable, and which relate to the classification of the mechanism, as shown in table 2, in the following equation :

$$D_1 \geqslant h_1 d \qquad \ldots(4)$$

or $$D_2 \geqslant h_2 d \qquad \ldots(5)$$

or $$D_3 \geqslant h_3 d \qquad \ldots(6)$$

where

D_1 is the pitch diameter of drum;

D_2 is the pitch diameter of pulley;

D_3 is the pitch diameter of compensating pulley;

d is the minimum diameter of rope, as defined in 5.1.1.

h_1 is the selection factor for drum (ratio of the pitch diameter of drum to the calculated diameter of the rope);

h_2 is the selection factor for pulley (ratio of the pitch diameter of pulley to the calculated diameter of the rope);

h_3 is the selection factor for compensating pulley (ratio of the pitch diameter of compensating pulley to the calculated diameter of the rope).

Table 2 — Selection factors h_1, h_2 and h_3

Classification of mechanism	Drums h_1	Pulleys h_2	Compensating pulleys h_3
M.1	11,2	12,5	11,2
M.2	12,5	14,0	12,5
M.3	14,0	16,0	12,5
M.4	16,0	18,0	14,0
M.5	18,0	20,0	14,0
M.6	20,0	22,4	16,0
M.7	22,4	25,0	16,0
M.8	25,0	28,0	18,0

However, it is recommended that for particular applications of lifting appliances, for example mobile cranes, a single set of h values be selected independent of the classification of the mechanism (see annex C).

7 Stationary ropes

Stationary ropes are fixed at both rope ends and are not subject to winding on a drum. Their selection is made in accordance with 5.1.2 with Z_p values modified as in table 3, where the

maximum rope tension (S) must be established by the manufacturer of the mechanism who must take account of both the static forces and those forces resulting from maximum wind and impact conditions.

Table 3 — Z_p values for stationary ropes

Classification of mechanism	Z_p value
M.1	2,5
M.2	2,5
M.3	3,0
M.4	3,5
M.5	4,0
M.6	4,5
M.7	5,0
M.8	5,0

8 Dangerous conditions

For dangerous conditions, for example the handling of molten metal,

a) no classification group lower than M.5 may be used;

b) the Z_p value shall be increased by 25 % up to a maximum of 9,0 or, alternatively, the C value for the next higher classification group shall be adopted, when selecting the rope.

9 Examination, maintenance and discard of wire ropes

The examination, maintenance and discard criteria for wire ropes are specified in ISO 4309 and the provisions laid down in that International Standard should be adopted.

Annex A

Lifting appliances (extracted from ISO 4306) to which this International Standard relates

This list is not comprehensive.

- Cable and portal cable cranes
- Cantilever cranes (pillar, jib, wall or walking)
- Deck cranes
- Derrick and guy derrick cranes
- Derrick cranes with rigid bracing
- Floating cranes
- Mobile cranes
- Overhead travelling cranes
- Portal or semi-portal bridge cranes
- Portal or semi-portal cranes
- Railway cranes
- Tower cranes

The cranes may be used for hook, grabbing, magnet, ladle, bucket or stacking duties and may be operated manually, electrically or hydraulically.

Annex B

Examples of wire rope selection

B.1 Example 1

A lifting appliance is to operate under duty conditions defined in the classification of mechanisms as M.3.

The maximum rope tension has been established as 79 kN.

The construction and tensile strength of the rope to be selected has a K' value of 0,294 8 and R_o value of 1 570 N/mm^2.

$$d \text{ min.} = 0{,}095 \sqrt{79\,000}$$
$$= 26{,}7 \text{ mm}$$

For practical purposes, the minimum diameter of the rope selected is not less than 27 mm.

Then from 5.1.2 using equation (3) :

$$\text{Minimum breaking load } F_o = 79 \times 4$$
$$= 316 \text{ kN}$$

For practical purposes, the minimum breaking load of the rope selected must not be less than 316 kN.

B.2 Example 2

Exactly similar parameters are required as indicated in example 1, but on this occasion the constructor of the appliance wishes to employ a smaller rope size to reduce equipment weight and therefore selects a rope construction and tensile strength having a K' value of 0,329 9 and R_o value of 1 770 N/mm^2.

Then from 5.1 using equation (1) :

$$C = \sqrt{\frac{4}{0{,}329\,9 \times 1\,770}}$$
$$= 0{,}082\,7 \text{ min.}$$

corrected to 0,085 (Renard number from R 40 series).

Then from 5.1.1 using equation (2) :

$$d \text{ min.} = 0{,}085 \sqrt{79\,000}$$
$$= 23{,}9 \text{ mm}$$

For practical purposes, the nominal diameter of the rope selected is not less than 24 mm.

Then from 5.1.2 using equation (3) as in example 1 :

$$\text{Minimum breaking load } F_o = 79 \times 4$$
$$= 316 \text{ kN}$$

Annex C

Limitation of h values for particular applications

Example : Mobile cranes

Independent of duty conditions.

$h_1 = 16$

$h_2 = 18$

$h_3 = 14$

Mobile cranes are frequently constructed for multi-purposes duties, i.e. hook lifting, grabbing or magnet operation, which would involve variations in mechanism classification and consequently differing values of h.

To avoid practical difficulties, it is proposed that values of h should remain constant irrespective of duty.

For lifting duties, the rope selection factor C or the minimum coefficient of utilisation Z_p shall be in accordance with mechanism classification M.4.

For more severe duties, i.e. magnet or grabbing operations, it is recommended that the maximum rope load be reduced by 20 %.