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Steel wire ropes — Pulling eyes for rope installation — Types and minimum requirements

Câbles en acier — Oeils de tirage pour les installations en câble — Types et exigences minimales

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Foreword

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 105, *Steel wire ropes*.

Introduction

This International Standard was developed in response to a worldwide demand for an International Standard identifying the different types of pulling eyes which are used to facilitate the installing and re-reeving of ropes on a machine.

Such pulling eyes, sometimes referred to as beckets, are often used when another rope is required to pull the new rope into place.

Steel wire ropes — Pulling eyes for rope installation — Types and minimum requirements

1 Scope

This International Standard identifies the different types of pulling eyes prepared at, or attached to, a steel wire rope end for connection to another rope when installing a new rope or re-reeving an existing rope on a machine.

This International Standard also specifies the minimum requirements for pulling eyes, including their geometry, strength, maximum line pull to which the pulling eye is intended to be subjected and information for use to be provided by the manufacturer.

The pulling eyes covered by this International Standard are not intended to be subjected to a load when the machine performs a service operation.

This International Standard applies to those pulling eyes prepared at, or attached to, ends of steel wire ropes conforming to ISO 2408 and ISO 10425.

This International Standard does not apply to steel wire ropes with fibre cores.

This International Standard does not cover those separate end connection accessories, which slide over the end of a rope and comprise an eye- and tubular-type braided rope, often referred to as a "wire rope stocking" or "cable sock".

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable to its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 17893, *Steel wire ropes — Vocabulary, designation and classification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17893 and the following apply.

3.1
pulling eye
end preparation or end attachment in the form of a loop or eye to facilitate installation or re-reeving of a steel wire rope on a machine

3.2
flexible-type pulling eye
end preparation or end attachment in the form of a loop or eye, made from components of rope

EXAMPLE Individual strands or core, or tapered outer strands, reduced by removing some of the constituent wires

Note 1 to entry: Pulling eyes made from the centre strand of the core have limited load capacity.

3.3
rigid-type pulling eye
end preparation or end attachment in the form of a loop or eye, made by welding a component, such as a pad eye, modified eyebolt or chain link to the end of a stranded rope

3.4
semi-rigid-type pulling eye
end preparation or end attachment in the form of a loop or eye, comprising looped short length of smaller diameter wire rope secured in two opposing gussets between outer strands of the larger parent rope by a swaged ferrule

3.5
single use pulling eye
end preparation or end attachment in the form of a loop or eye located on the drum end of the rope for the purposes of installation and subsequent removal of the rope following a single service life

3.6
multiple use pulling eye
end preparation or end attachment in the form of a loop or eye, fitted to rope intended to experience multiple service life

EXAMPLE Installation and/or multiple re-reeving or end for ending the rope

4 Requirements

4.1 General

The manufacturer shall prepare detailed manufacturing instructions for each type of pulling eye that they intend to produce. These instructions shall, at least, as applicable to the type of pulling eye, include the following aspects:

— the rope types and diameters for which the pulling eye type is suitable;

— method for preparing the rope end;

— matching the pad eye, modified eyebolt or chain link to the rope;

— method for welding component to the rope;

— method for forming the eye or loop;

— method for preparing the tapered section;

— inspection criteria.

The manufacturer's instructions shall be supported by a written declaration stating that the system has passed the type testing requirements of 4.3.

Pulling eyes shall be made in accordance with the manufacturer's instructions.

In the case of the welded components attached to the rope end, the welding shall be performed by a qualified person.

Qualification procedure shall be performed as defined in 4.5.

Requalification is not required, provided a minimum of three component welds are made during any 12-month period.

4.2 Geometry

4.2.1 Flexible-type pulling eye made from the centre strand of the core

The dimensions of the eye or loop shall be such that it shall be possible for its shape to change sufficiently enough to pass the completed pulling eye through an aperture of equivalent size to the diameter of the rope which is to be installed.

The internal length of the eye or loop, as manufactured, shall be at least three times the diameter of the rope.

An illustration of such a completed pulling eye is given in Figure 1.

Figure 1 — Completed flexible pulling eye made from the centre strand of the core

4.2.2 Flexible-type pulling eye made from the steel core itself

The internal length of the eye or loop, as manufactured, shall be at least five times the diameter of the rope.

An illustration of such a completed pulling eye is given in Figure 2.

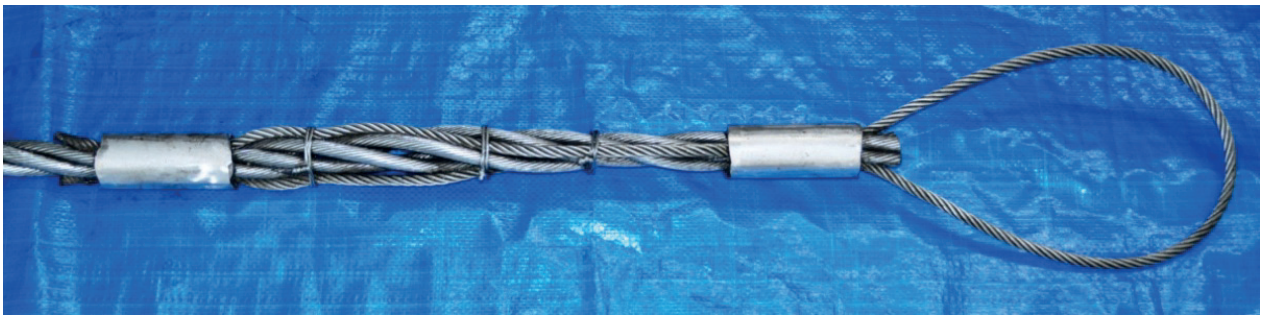
NOTE It is not usually possible for a pulling eye made from the steel core itself to be passed through an aperture of equivalent size to the diameter of the rope.

Figure 2 — Completed flexible pulling eye made from the steel core itself

4.2.3 Flexible-type pulling eye secured with pressed ferrules

The internal length of the eye or loop, as manufactured, shall be at least five times the diameter of the rope.

Two examples of flexible pulling eyes secured with pressed ferrules are illustrated in Figure 3 a) and b).



a) Flexible pulling eye incorporating auxiliary strand secured by pressed ferrules

b) Flexible pulling eye made from the steel core and secured with pressed ferrules

Figure 3 — Flexible pulling eye

4.2.4 Rigid-type pulling eye

The diameter of a pad eye or modified eyebolt at its base shall be such that it will allow for a continuous fillet weld to be applied around its periphery in the first welding pass to secure it to the rope end.

The maximum dimensions of the pad eye, modified eyebolt or chain link shall be no greater than the diameter of the rope.

An illustration of a completed pad eye or modified eyebolt-type pulling eye is given in Figure 4.

Figure 4 — Typical pad eye or modified eyebolt pulling eye

An illustration of a rigid-type pulling eye incorporating a welded chain link in Figure 5.

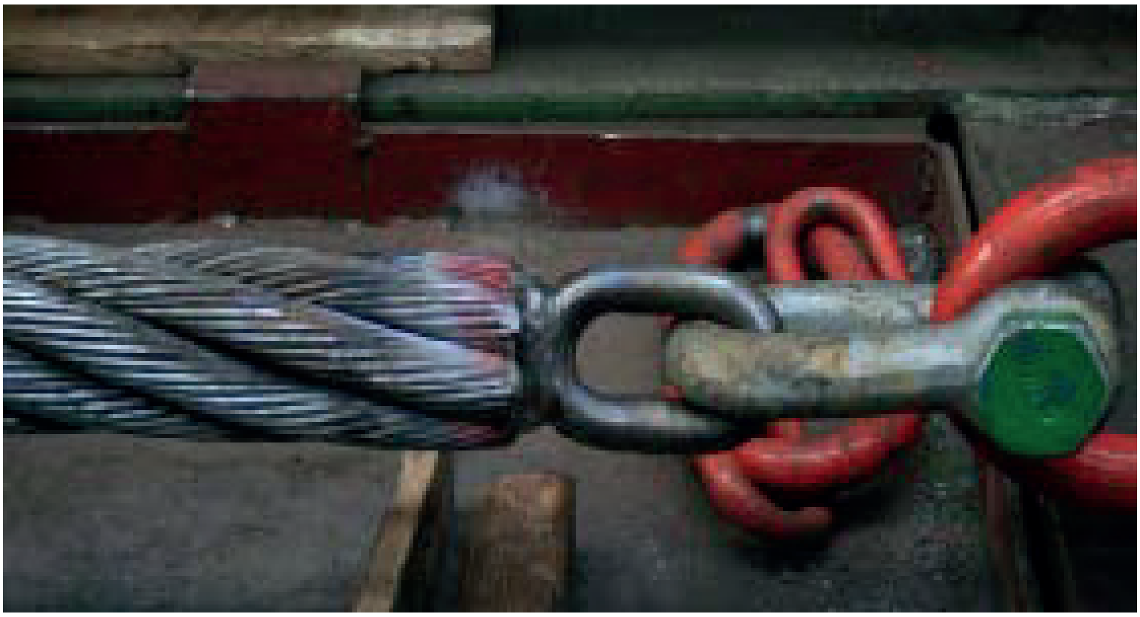


Figure 5 — Rigid-type pulling eye incorporating welded chain link

4.2.5 Semi-rigid type pulling eye

The selected diameter of the looped short length of rope shall be such that it protrudes above the parent rope diameter when inserted into the gusset between the outer strands of the parent rope prior to the compaction of the circumscribing swaged ferrule.

An illustration of a semi-rigid-type pulling eye is given in Figure 6.

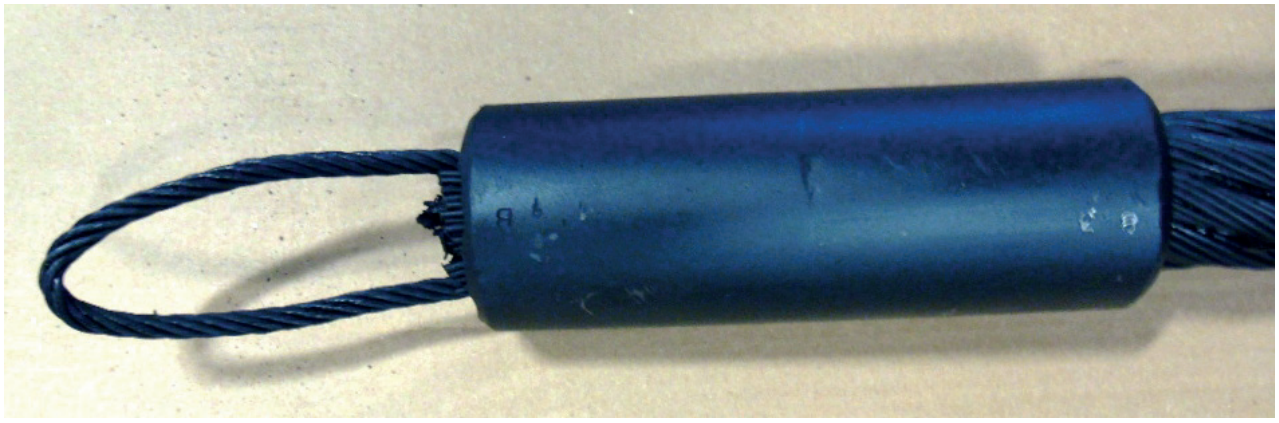


Figure 6 — Example of a semi-rigid pulling eye termination

4.3 Type testing

4.3.1 Sampling

For each class of rope and rope grade in accordance with ISO 17893 and pulling eye type, the following shall apply.

— Where the pulling eye design follows a mathematical progression throughout a given size range, rope diameters shall be selected for testing to represent the upper and lower quartiles of that range.

— Where the pulling eye does not follow a mathematical progression through a size range, each rope diameter within that range for which the pulling eye is designed shall be selected for testing.

— For rigid-type pulling eye, each rope diameter within the range for which the pulling eye is designed shall be selected for testing.

NOTE Rope of the same diameter, but of different construction e.g. 8 × 19S and 8 × 36WS can contain significantly different wire diameters. Welding settings, electrode size, etc. suited to one construction will not necessarily suit the other construction, hence the need for process validation on each rope within the range.

4.3.2 Minimum breaking force of pulling eye ($F_{p,e,min}$)

The pulling eye manufacturer shall determine the minimum breaking force of the pulling eye, $F_{p,e,min}$, and indicate the value on the certificate of compliance (see 6.2).

In the case of the flexible-type pulling eyes, the manufacturer shall take account of the strength of the centre strand of the core or the core itself, as applicable, and also the efficiency of the Flemish eye of the core strand or the splice efficiency of the core itself, as applicable.

When tested in accordance with 5.1, the measured breaking force of the pulling eye shall equal or exceed the specified minimum breaking force of the pulling eye.

4.3.3 Durability of pulling eyes intended to be used for multiple re-reeving operations

When tested in accordance with 5.2, the pulling eye shall be capable of being loaded at least one thousand times between loads equivalent to 25 % and 125 % of the specified working load limit.

In the event that this number of repeated loadings is not achieved, the design shall be modified and the tests repeated.

If the results from these repeat tests fail to achieve the required number of loadings, the pulling eye shall be deemed not to conform to this International Standard.

4.4 Pulling eye working load limit (WLL)

The working load limit, i.e. maximum axial line pull to which the pulling eye should be subjected during installation or a re-reeving of the rope, shall be determined by the pulling eye manufacturer and its value marked on the pulling eye or rope tag (see 6.1) and indicated on the certificate (see 6.2).

The working load limit, *WLL*, shall be based on a working coefficient (coefficient of utilization), Z_p, of 3,15:

$$WLL = \frac{F_{p,e,min}}{Z_p \times g} \quad (1)$$

where

WLL is the working load limit, in tonnes;

$F_{p,e,min}$ is the minimum breaking force of pulling eye, in kilonewtons;

Z_p is the coefficient of utilization with an allocated value of 3,15;

g is the factor relating mass to force and has the value = 9,806 65.

4.5 Welder qualification for rigid-type pulling eyes

The welder shall be qualified by “representative weld test”.

Qualification by “representative weld test” is based upon the completion of welding and subsequent tensile testing of a test assembly. On successful completion of test, the operative shall be permitted to weld pad eyes, eyebolts or chain links on to rope of diameter and construction covered by this International Standard.

The welder shall be supplied with a rope of diameter and construction appropriate to those required for subsequent production. The sample length shall be at least 1,5 times the rope lay length and shall have the ends served and cut square.

The welder shall weld a pad eye/eyebolt/chain link on to both ends of the rope sample in accordance with 5.2.

The complete termination assembly (including connecting shackles) shall be capable of withstanding an inline tensile load of greater than or equal to the minimum breaking force of the pulling eye.

The test sample shall be loaded to destruction and the load at which the sample fails shall be recorded.

The welder shall be considered to have passed the test only after the sample has failed at a load in excess of the minimum breaking force value quoted for the size of pulling eye selected.

5 Verification of the requirements

5.1 Tensile test

The sample shall be prevented from rotating at its ends.

The applied force shall be transmitted by means of round pins.

For the flexible-type pulling eyes, the diameter of the pin shall be selected so that an included angle of taper between 25° and 35° is subtended by the eye or loop.

After 50 % of the minimum breaking force of the pulling eye has been applied, the force shall be increased at a rate of not more than 0,5 % of the minimum breaking force of the pulling eye per second.

The free length of rope in the sample, i.e. excluding any length attributed to the pulling eye and any tapered portion at one end and any termination at the other, shall be at least 1,5 rope lay lengths.

The testing machine shall comply with ISO 7500-1 class 1.

5.2 Durability test

The test shall be carried out on an inline tensile fatigue testing machine.

The sample shall be prevented from rotating at its ends and the test shall consist of the application of a cyclical force equivalent to 25 % (lower value) and 125 % (upper value) of the specified working load limit (WLL) along the rope axis.

The cyclical test frequency shall not exceed 5 Hz in an ambient temperature of 10 °C to 40 °C.

The applied force shall be transmitted by means of round pins.

For the flexible-type pulling eyes, the diameter of the pin shall be selected so that an included angle of taper between 25° and 35° is subtended by the eye or loop.

The free length of rope in the sample, i.e. excluding any length attributed to the pulling eye and any tapered portion at one end and any termination at the other, shall be at least 1,5 rope lay lengths.

6 Information for use

6.1 Marking

The pulling eye assembly shall be legibly and indelibly marked with the working load limit (*WLL*), in tonnes (e.g. 2,50 t), and for values less than 1 tonne, in kilograms (e.g. 500 kg).

6.2 Certificate of compliance

Together with any other information concerning the rope itself, the certificate of compliance shall additionally include at least the following information:

— reference to this International Standard, i.e. ISO 16841;

— minimum breaking force of the pulling eye;

— working load limit, in tonnes, and for values less than 1 tonne, in kilograms;

— whether the pulling eye is for single use or multiple use.

Annex A
(informative)

Determination of the line pull to which the pulling eye is subjected during installation or a re-reeving operation

When specifying a pulling eye, the user, machinery manufacturer or purchaser of the rope should calculate the maximum line pull to which the pulling eye will be subjected during a rope installation or a re-reeving operation and include this value in the enquiry and on the order for the rope along with an indication as to whether the pulling eye is to be for single use or multiple use.

As part of this exercise, the user, machinery manufacturer or purchaser of the rope should at least take account of the following when calculating the line pull:

— rope mass effects;

— efficiency of the reeving arrangement;

— fleet angle;

— acceleration and any shock loading effects;

— wind effects;

— mass of any associated equipment, which is lifted or pulled during installation or re-reeving operations;

— any friction effects.

The above-mentioned list is not exhaustive.

Bibliography

[1] ISO 2408, *Steel wire ropes for general purposes — Minimum requirements*

[2] ISO 10425, *Steel wire ropes for the petroleum and natural gas industries — Minimum requirements and terms of acceptance*

[3] ISO 17558, *Steel wire ropes — Socketing procedures — Molten metal and resin socketing*

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