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# Non-parallel steel wire and cords for tyre reinforcement

*Fils d'acier et cordes non parallèles pour le renfort de pneumatiques*



Reference number
ISO 17832:2018(E)

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# Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 17, *Steel wire rod and wire products*.

This second edition cancels and replaces the first edition (ISO 17832:2009), which has been technically revised.

The following changes have been made:

— tensile strength for UT, ST and NT constructions has been updated;

— HI construction has been added;

— the tolerance for lay length has been narrowed from "±10 %" to "±5 %";

— the tolerance of residual torsion for HE construction has been narrowed from ±4 torsion/6 m to ±3 torsion/6 m;

— the tolerance for spool length has been narrowed;

— the weld breaking load for HT, ST and UT constructions has been increased.

# Non-parallel steel wire and cords for tyre reinforcement

## 1 Scope

This document specifies the definition and requirements of non-parallel steel wire and cords for tyre reinforcement.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 3951-1, *Sampling procedures for inspection by variables — Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL*

ISO 3951-2, *Sampling procedures for inspection by variables — Part 2: General specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection of independent quality characteristics*



ISO 3951-3, *Sampling procedures for inspection by variables — Part 3: Double sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*



ISO 3951-5, *Sampling procedures for inspection by variables — Part 5: Sequential sampling plans indexed by acceptance quality limit (AQL) for inspection by variables (known standard deviation)*

## 3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

**3.1**
**filament**
metal fibre with a metallic alloy coating used as an individual element in a *strand* (3.2) or *cord* (3.3)

**3.2**
**strand**
group of *filaments* (3.1) combined together to form a unit product for further processing

**3.3**
**cord**
formed structure composed of two or more *filaments* (3.1) when used as an end product, or a combination of *strands* (3.2) or filaments and strands

**3.3.1**
**single-strand cord**
*cord* (3.3) formed by twisting two or more *filaments* (3.1) together

**3.3.2**
**M+N type cord**
*cord* (3.3) formed by twisting a number of non-concentric *filaments* (3.1) around a number of parallel filaments

Note 1 to entry: The cross-section is not round and varies along the length.

**3.3.3**
**layer cord**
*cord* (3.3) formed by adding layers around a core

Note 1 to entry: The layers can be filaments or strands.

**3.3.4**
**multi-strand cord**
*cord* (3.3) formed by twisting two or more *strands* (3.2) together

**3.4**
**wrap**
*filament* (3.1) wound helically around a steel *cord* (3.1)

**3.5**
**direction of lay**
helical disposition of the components of a *strand* (3.2) or cord

Note 1 to entry: The strand or cord has an "S" or left-hand lay, when held vertically, if the spirals around the central axis of the strand or cord conform in direction of slope to the central portion of the letter "S".



Note 2 to entry: The strand or cord has a "Z" or right-hand lay if the spirals conform in direction of slope to the central portion of slope of the letter "Z".



**3.6**
**length of lay**
axial distance required to make a 360° revolution of any element in a *strand* (3.2) or in a *cord* (3.3)

Note 1 to entry: The length of lay is expressed in millimetres.

# 4 Classification

## 4.1 Classification based on tensile strength

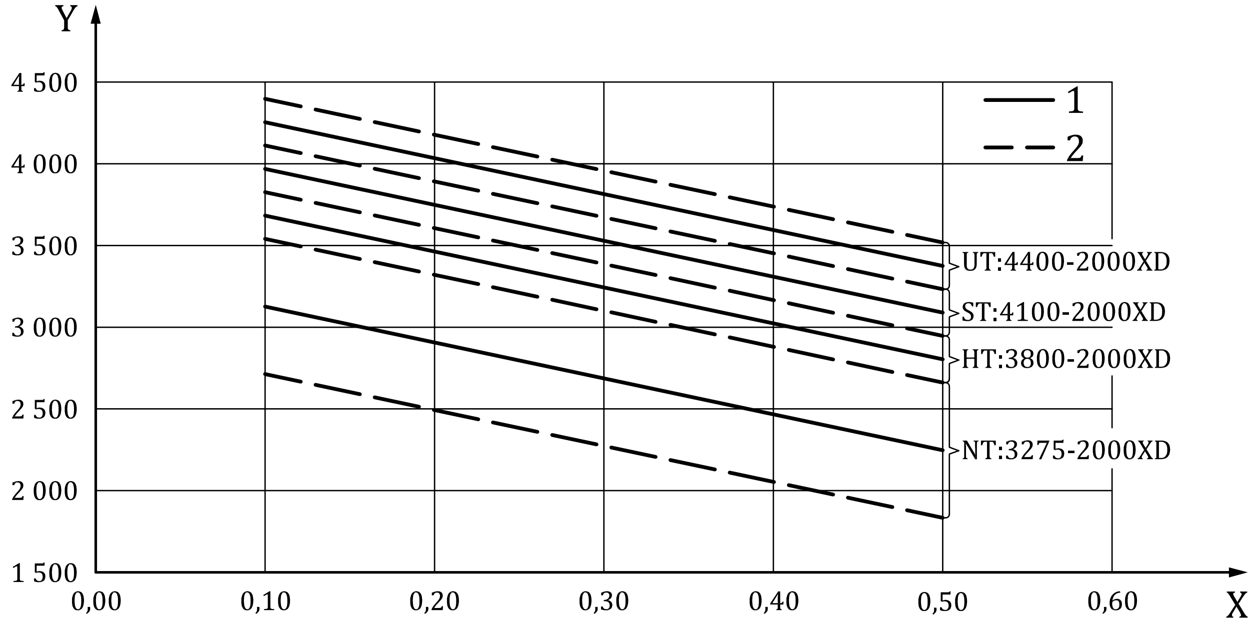
Steel cord is supplied in levels of tensile strength (see Figure 1), designated as follows:

— NT: normal standard (or regular) tensile strength cord;

— HT: high tensile strength cord;

— ST: super tensile strength cord;

— UT: ultra tensile strength cord.




**Key**

X filament diameter, mm
Y filament tensile strength, MPa
1 solid line indicates target value
2 dashed line indicates tolerance range

NOTE The target value is determined by agreement between the manufacturer and the purchaser.



**Figure 1 — Tensile strength levels**



Figure 1 gives the tensile strength levels of wet-drawn filaments. The cord breaking load is calculated from the filament number, lay length and cabling loss. For example, cord construction 2x0,30ST 14/S is calculated by Formula (1):

$$F = n \times (f \times \cos \alpha) \times (1 - C) \quad (1)$$

where

$F$ is the breaking load of cord construction 2x0,30ST 14/S, in mega pascals;

$f$ is the breaking load of 0,30ST, in mega pascals;

$\alpha$ is the cabling angle, in degrees;

n is the number of filament;

$C$ is the cabling loss on tensile strength (e.g. 4 %).

## 4.2 Classification based on cord structure

The main classification based on cord structure is categorized by the following four structures:

— single-strand cords;

— M+N type cords;

— layer cords;

— multi-strand cords.

### 4.3 Classification based on cord type

The main classification based on cord type is categorized by the following four types:

— HE: high-elongation cord;

— OC: open cord;

— CC: compact cord;

— WC: wavy cord, a cord with filaments preformed in 2 or 3 dimensional wavy shape in order to improve rubber penetration;

— HI: high impact cord.

Another detailed classification may be used if there is mutual agreement between the manufacturer and the purchaser.

## 5 Designation and ordering

A tyre cord construction is normally defined by

— cord structure,

— cord tensile strength,

— cord type,

— length and direction of lay, and

— coating type.



### 5.1 Cord structure

The description of the cord structure follows the sequence of manufacture of the cord, i.e. starting with the innermost strand or wire and moving outwards.

The full description of the cord structure is given by the following formulas:

$(N \times X) \times D + (N \times X) \times D + (N \times X) \times D + D$, or

$(N \times X) \times D/(N \times X) \times D/(N \times X) \times D + D$ for compact cords, and

$(N \times N) \times D + D$

where

$N$ is the number of strands;

$X$ is the number of filaments;

$D$ is the nominal diameter of wires, expressed in millimetres.

EXAMPLE 1 (1 × 3) × 0,22 + (1 × 9) × 0,22 + (1 × 15) × 0,22 + 0,15.

When $N$ or $F$ equals 1, they should not be included.

EXAMPLE 2 3 × 0,22 + 9 × 0,22 + 15 × 0,22 + 0,15.

If the diameter *D* is the same for two or more parts in sequence, it shall only be stated at the end of the sequence.

The diameter of the spiral wrap shall always be stated separately.

EXAMPLE 3 3 + 9 + 15 × 0,22 + 0,15.

When the innermost strand or wire is identical to the adjacent strand or wires, the formula may be simplified by stating only the sum of the identical components and brackets need not be used.

EXAMPLE 4 0,22 + 6 × 0,22 + 6 × (0,22 + 6 × 0,22) becomes 7 × 7 × 0,22.

## 5.2 Cord tensile strength

There are four levels of tensile strength: NT, HT, ST and UT as defined in 4.1. The tensile class of the spiral wrap is not governed by the tensile class levels.

## 5.3 Cord type

See 4.3

## 5.4 Length and direction of lay

The sequence or order in the designation follows the sequence of manufacturing, i.e. starting with the innermost strand and moving outwards.



EXAMPLE 1

3 + 9 + 15 × 0,175 + 0,15

5/10/16/3.5 SSZS

5 S: lay length and direction of the strand 3 × 0,175

10 S: lay length and direction of the strand + 9 × 0,175

16 Z: lay length and direction of the strand + 15 × 0,175

3,5 S: lay length and direction of the spiral wrap

EXAMPLE 2

7 X (3 + 9 + 15 × 0,175) + 0,20

(5/10/16)/(5/10/16)/38/5 SSS/ZZZ/S/Z

5 S: lay length and direction of the innermost strand 3 × 0,175

10 S: lay length and direction of the innermost strand + 9 × 0,175

16 S: lay length and direction of the innermost strand + 15 × 0,175

5 Z: lay length and direction of the adjacent strand 3 × 0,175

10 Z: lay length and direction of the adjacent strand + 9 × 0,175

16 Z: lay length and direction of the adjacent strand + 15 × 0,175

38 S: lay length and direction of the cable

5 Z: lay length and direction of the spiral wrap

### 5.5 Coating type

There are two classic types of brass coating: high-copper coating and normal copper coating, as listed in Table 2. More advanced metallic alloy coatings such as Cu-Zn-Co are possible.

## 6 Requirements

### 6.1 General

Specified tests are mainly conducted in accordance with internationally agreed methods for steel tyre cords, such as ASTM D2229-10, ASTM D2969-04, BISFA, JIS G 3510, etc.

### 6.2 Dimensions, mass and tolerances

#### 6.2.1 Diameter of cord

The diameter of the circumscribed circle of cord, in millimetres, and detailed requirements are listed in Table 5.

#### 6.2.2 Linear density

The linear density, i.e. the mass of a 1 m length of cord, in grams per metre (g/m), and detailed requirements are listed in Table 5.



#### 6.2.3 Tolerances

The tolerance of the cord length shall conform to Table 1.



Tolerance of filament diameter: ±10 µm.

Tolerance of lay length: ±5 %.

Tolerance of residual torsion of cord: ±3 torsions/6 m in general.

**Table 1 — The tolerance of the cord length**

| Cord length, *L*<br>m | Tolerance[a]<br>% |
|---|---|
| L ≤ 2 000 | ±0,75 % |
| >2 000 approximately 8 000 | ±0,50 % |
| >8 000 | ±0,25 % |

[a] With a minimum of ±10 m.

### 6.3 Welds and splices

Continuous lengths shall be supplied as follows:

Cord may be welded and shall withstand a minimum load as follows:

— for NT,HT cord: 40 % of the minimum breaking load of the cord;

— for ST,UT cord and off-the-road cords: 35 % of the minimum breaking load of the cord.

An additional bending test is needed for the control of the welds.

In the case of layer cords, splicing or a simple knot filament connection can be used in lieu of welds, except in the outer-most layer.

The increase in diameter of the finished weld or splicing shall not exceed the cord diameter by more than 10 % (or 20 %, if agreed between the manufacturer and the purchaser).

The number of cord welds shall not exceed:

— 3 per spool type BS40 or BS60;

— 6 per spool type BS80;

— 30 % of spools per box or delivery lot by agreement between the manufacturer and the purchaser (based on 72 BS40/60 spools per box or 36 BS80 spools per box).

The dimensions of typical spool types are shown in Table 3.

## 6.4 Mechanical properties

### 6.4.1 Breaking load and elongation at fracture

A specimen of cord is clamped in a tensile-testing apparatus under a defined pre-tension and is subjected to a constant rate of extension until the cord breaks; if the specimen has a spiral wrap, it shall be removed from the length of the specimen in contact with the clamps.

Only clamps which do not cause fractures in the vicinity of the clamped area shall be used.

### 6.4.2 Structural elongation



Structural elongation (e.g. part load elongation at 2,5 N to 50 N) is the increase in length between defined tension levels, expressed as a percentage of the original gauge length.

## 6.5 Technological properties



### 6.5.1 Straightness

The steel cord sample is put on a smooth surface on which two parallel lines 6 m long and 75 mm apart are marked. The steel cord sample should stay between the two lines.

### 6.5.2 Arc height

After releasing the end of the specimen used for the residual torsion determination, the arc height, expressed in millimetres, at a specified inter-distance shall be measured.

The specified inter-distance may be 300 mm or 400 mm.

### 6.5.3 Residual torsion

One end of a specified length (normally 6 m) of cord is allowed to turn freely: the number of revolutions is counted as residual torsion and the direction is noted.

### 6.5.4 Flare

The flare of the end of the specimen should not be more than the length of the lay or the amount which might influence the process-ability and/or the laboratory test, such as the adhesion test.

### 6.5.5 Steel cord elasticity

Steel cord elasticity, expressed as a percentage, is the degree to which a cord reverts to its original form after having been subjected to a specific bending deformation.