INTERNATIONAL STANDARD

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Second edition
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Steel cord conveyor belts —

Part 3: Special safety requirements for belts for use in underground installations

Courroies transporteuses à câbles d'acier —

Partie 3: Exigences de sécurité particulières aux courroies utilisées dans des installations souterraines

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 41 *Pulleys and belts (including veebelts)*, Subcommittee SC 3, *Conveyor belts*.

This second edition cancels and replaces the first edition (ISO 15236-3:2007), of which it constitutes a minor revision with the following changes:

— the references have been updated;

— Table 3 has been expanded to include belt widths from 1 800 to 3 200.

A list of all parts in the ISO 15236 series can be found on the ISO website.

Steel cord conveyor belts —

Part 3:
Special safety requirements for belts for use in underground installations

1 Scope

This document specifies the performance and constructional requirements applicable to conveyor belts for underground mining having steel cords in the longitudinal direction as reinforcement. The requirements for design and construction apply to the design of single belts, as well as the design of complete type series such as those covered in ISO 15236-2.

Steel cord belts in accordance with this document are intended for use underground in coal mines and in other applications where the highest demands for safety against fire and explosion hazards have to be complied with.

NOTE At present, the requirements can only be met by the use of compounds based on chloroprene rubber for the covers, as well as for the bonding rubber.

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 indicated applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 703, *Conveyor belts — Transverse flexibility (troughability) — Test method*

ISO 2062, *Textiles — Yarns from packages — Determination of single-end breaking force and elongation at break*

ISO 4649, *Rubber, vulcanized or thermoplastic — Determination of abrasion resistance using a rotating cylindrical drum device*

ISO 7590, *Steel cord conveyor belts — Methods for the determination of total thickness and cover thickness*

ISO 7622-2, *Steel cord conveyor belts — Longitudinal traction test — Part 2: Measurement of tensile strength*

ISO 7623, *Steel cord conveyor belts — Cord-to-coating bond test — Initial test and after thermal treatment*

ISO 8094, *Steel cord conveyor belts — Adhesion strength test of the cover to the core layer*

EN 13827, *Steel cord conveyor belts — Determination of the lateral and vertical displacement of steel cords*

EN 14973, *Conveyor belts for use in underground installations — Electrical and flammability safety requirements*

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 http://www.iso.org/obp

3.1
edge width
b_k
thickness of rubber between the outer cord and the belt edge

Note 1 to entry: See Figure 1.

3.2
breaker
transverse reinforcement in the conveyor belt, normally of a textile material, attached both above and below or either above or below the layer of longitudinal cords at a distance of at least 1 mm and considered to be part of the cover

Note 1 to entry: See Figure 2.

[SOURCE: ISO 7590:2009, 2.1, modified]

3.3
weft
transverse reinforcement in the conveyor belt, normally of steel wires, attached both above and below or either above or below the layer of longitudinal cords at a distance of less than 1 mm and considered to be part of the belt core

Note 1 to entry: See Figure 3.

[SOURCE: ISO 7590:2009, 2.2, modified]

4 Symbols and units

See Table 1.

Table 1 — Symbols and units

Symbol	Explanation	Unit
B	Belt width	mm
F_a	Pull-out force of cord per cord length	N/mm
F_{bs}	Breaking strength of cord taken from cured belt	kN
F_v	Pull-out force of cord per cord length, after thermal treatment	N/mm
K_N	Minimum (nominal) breaking strength per width of belt	N/mm
b_k	Calculated edge width	mm
b_t	Supporting belt width	mm
d	Cord diameter	mm
e	See Figure 4	mm
F	Deflection (troughability)	mm
h_m	Median cord height according to EN 13827	mm
n	Number of cords	—
s_1	Nominal belt thickness (see ISO 7590)	mm
s_2	Cover thickness carrying side	mm
s_3	Cover thickness pulley side	mm

Table 1 *(continued)*

Symbol	Explanation	Unit
s_4	Thickness of layer between breaker and layer of longitudinal cords	mm
s_5	Thickness of layer between weft and layer of longitudinal cords	mm
s_6	Thickness of belt core	mm
t	Cord spacing/pitch	mm
Δh_1	Number of cords positioned within a range of $h_m \leq 1$ mm as a percentage of the total number of cords	%
Δh_2	Number of cords positioned within a range of h_m of from >1,0 mm to 1,5 mm and expressed as a percentage of the total number of cords	%
Δh_3	Percentage of cords with $h_m > 1{,}5$ mm	%

5 Belt design

5.1 Standard type

Conveyor belts conforming to this document contain steel cords surrounded by a layer of core rubber. This belt core is protected on top and bottom by cover layers (see Figure 1).

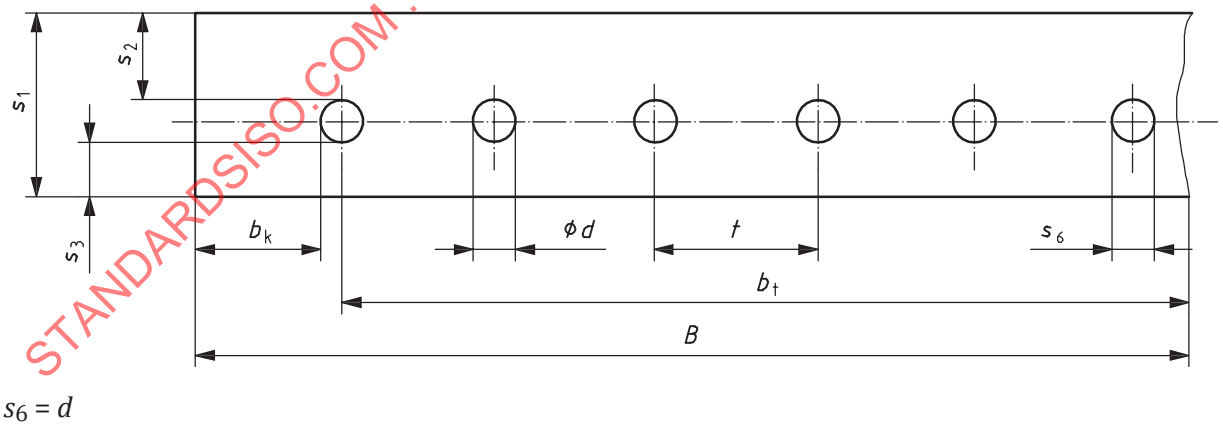
5.2 Conveyor belting having transverse reinforcements

Requirements for steel cord conveyor belts having breakers are illustrated in Figure 2 and requirements relating to weft are illustrated in Figure 3.

5.3 Belt core

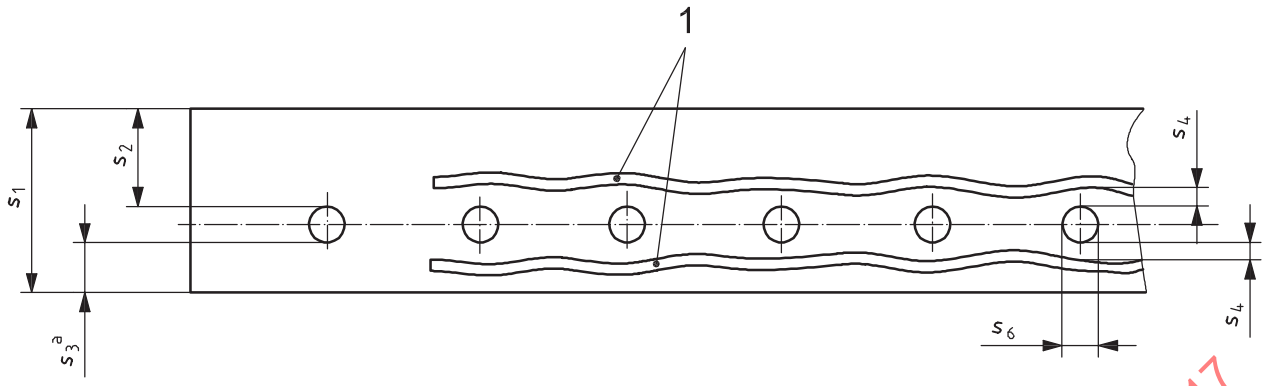
The thickness of the belt core (carcass), s_6, for all belt types is defined as follows:

$$s_6 = s_1 - s_2 - s_3$$



$s_6 = d$

Figure 1 — Cross section of standard belt



s_4 = W 1 mm

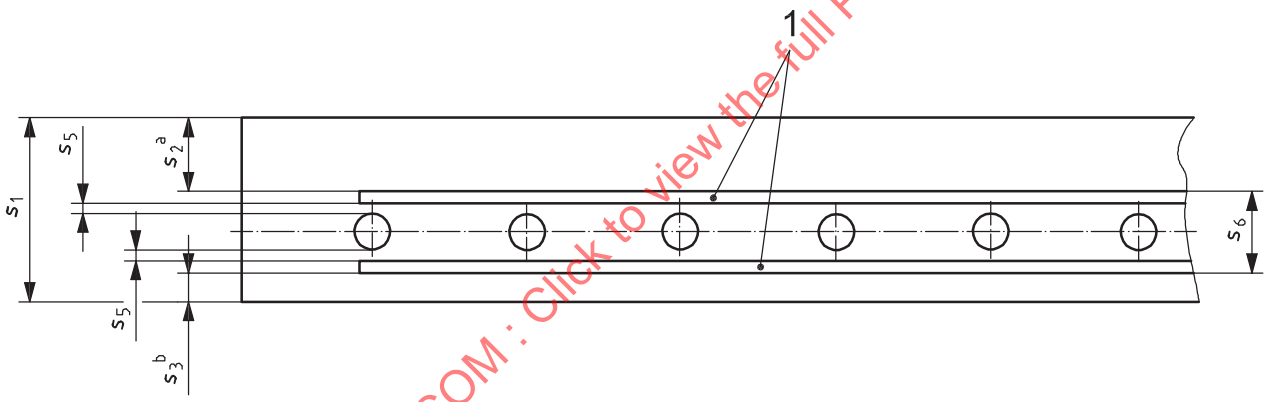
s_6 = d (see Table 1)

Key

1 breaker

a Including the breaker.

Figure 2 — Belt cross section with breaker



s_5 = <1 mm

Key

1 weft

a Above the weft.

b Below the weft.

Figure 3 — Belt cross section with weft

6 Design and construction

6.1 Belt strengths

Steel cord belts shall be manufactured in strengths of between 500 N/mm and 8 000 N/mm belt width.

The selection of preferred belt types shown in Table 2 should be used.

Table 2 — Belt types

ST 1000	ST 1250	ST 1600	ST 2000	ST 2500	ST 3150
ST 3500	ST 4000	ST 4500	ST 5000	ST 5400	

6.2 Belt width

The belt widths and tolerances according to Table 3 shall apply only to belts when manufactured and not to belts when tensioned on site.

Table 3 — Belt widths, B

Dimensions in millimetres

B													
500	650	800	1 000	1 200	1 400	1 600	1 800	2 000	2 200	2 400	2 600	2 800	3 000	3 200
$^{+10}_{-5}$	$^{+10}_{-7}$	$^{+10}_{-8}$	±10	±10	±12	±12	±14	±14	±15	±15	±15	±15	±15	±15

6.3 Belt edge and supporting belt width

6.3.1 Edge width

The edge width shall not be less than 15 mm and not more than 40 mm. Within these limits, the calculated edge width, b_k, is approximated from Formula (1):

$$b_k \approx 5 \times s_6 \tag{1}$$

6.3.2 Supporting belt width

The supporting belt width, b_t, is derived from Formula (2):

$$b_t = B - 2b_k - d \tag{2}$$

See also 7.2.2.

6.4 Number of cords

Based on the minimum breaking strength of the cord, F_{bs} (see 7.1), in kilonewtons (kN), the minimum breaking strength of the belt, K_N, in newtons per millimetre (N/mm) of belt width, and on the width of the belt, B, in millimetres (mm), the minimum number of cords, n_{min}, is given by Formula (3):

$$n_{min} = \frac{K_N \times B}{F_{bs} \times 1\,000} \tag{3}$$

The actual number of cords, n, shall be greater than or equal to n_{min}.

6.5 Cord pitch

The cord pitch, t, is calculated using Formula (4):

$$t = \frac{b_t}{n-1} \tag{4}$$

The cord pitch shall be selected to the nearest 0,1 mm.

The calculated edge width, b_k, is given by Formula (5):

$$b_k = 0,5 \times [B - d - t \times (n - 1)] \quad (5)$$

6.6 Thickness of covers

For standard type belts (see 5.1), the minimum thickness of either of the covers (s_2 or s_3) shall be not less than 0,7d or not less than 4 mm, whichever is the higher value.

For belts with transverse reinforcements (see 5.2), the minimum cover thickness for belts with breaker, depending on breaker design, may be higher. The minimum cover thickness for belts with a weft may be lower.

The cover thicknesses employed shall be determined taking into account cover grade and conveying conditions. The sum of the cover thicknesses (s_2 + s_3) influences the flammability of the belt and therefore a minimum value has to be observed, the tolerance on which shall be +1 mm and −0,5 mm, when measured according to ISO 7590.

6.7 Belt thickness

The thickness, s_1, is the result of the addition of the core thickness, s_6, and the cover thicknesses s_2 and s_3.

When measured according to ISO 7590, the maximum belt thickness shall be (s_1 + 2) mm.

The belt surfaces shall be plain and parallel and any difference in belt thickness (e.g. at the edges and across the belt centre) shall not exceed 0,05 × total belt thickness measured in accordance with ISO 7590.

6.8 Belt length

Belting shall be supplied subject to the tolerances on length detailed in Table 4.

When placing orders for belting, purchasers should specify a length of belting that includes such lengths as are required for jointing and external testing.

Table 4 — Tolerances on belt lengths

Belt delivery condition	Maximum permissible difference between delivered and ordered lengths
For a belt delivered in one complete length	$^{+2,5\ \%}_{0}$
For belt delivered in several lengths	±5 % for each single length, subject to an overall tolerance for the sum of all lengths of $^{+2,5\ \%}_{0}$

7 Mechanical requirements

7.1 Breaking strength of the steel cord

The breaking strength of the cord shall be proved by the test certificate of the cord manufacturer. Alternatively, if a test of the cord taken from the belt is requested, the test shall be carried out in accordance with ISO 7622-2.

The breaking strength of the cord, F_{bs}, shall at least be equal to the product of the minimum breaking strength of the belt, K_N, and the belt width, B, divided by the number of cords, n, i.e.

$$F_{bs} \geq \frac{K_N \times B}{n \times 1\,000}$$

7.2 Position of the steel cord in the conveyor belt

7.2.1 General

The position of the cords shall be determined according to EN 13827.

7.2.2 Horizontal position

The cords in the belt shall be rectilinear. Not more than 5 % of the steel cords shall deviate from the nominal cord pitch by more than ±1,5 mm when measured in accordance with EN 13827.

The deviation of the supporting belt width, b_t, from the arithmetic value $[(n - 1) \times t]$, shall not exceed 1 %.

7.2.3 Vertical position

The steel cords of the belt shall be in one plane. When measured in accordance with EN 13827, the value of Δh_1 shall be at least 95 %, the value of Δh_2 shall not exceed 5 % and the value of Δh_3 shall be zero.

7.3 Number and spacing of cord joints

In any individual length of conveyor belt (see 6.8), not more than 2 % of the total number of cords, n, may be joined and no individual cord shall have more than one joint.

The distance between joints in the longitudinal direction shall be greater than 10 m.

7.4 Cord pull-out force

The adhesion force between rubber and steel cord is critical for the transmission of forces in a steel cord reinforced conveyor belt and its joints.

The adhesion force between rubber and steel cord is represented in the as-delivered state by F_a and after thermal treatment by F_v.

When tested in accordance with ISO 7623, the cord pull-out forces F_a and F_v shall meet the requirements given in Table 5. For thermal treatment, a temperature of (145 ± 5) °C for (150 ± 1) min shall be used, except that, when testing belts that are intended to be repaired and/or reconditioned several times or intended to be spliced during service, a temperature of (155 ± 5) °C for (240 ± 1) min shall be used.

Table 5 — Performance requirements for cord-to-coating bond strength per cord length

Test conditions	Cord pull-out forces N/mm	
	$F_{a\,min}$	$F_{v\,min}$
As-delivered state:		
Without transverse reinforcement	$15d + 15$	—
With transverse reinforcement	$17d + 20$	—
After thermal treatment (145 ± 5) °C for (150 ± 1) min or (155 ± 5) °C for (240 ± 1) min:		
Without transverse reinforcement	—	$15d + 5$
With transverse reinforcement	—	$17d + 20$

7.5 Covers — Quality classification

When tested in accordance with ISO 37 and ISO 4649, method A, the conveyor belt covers shall comply with the requirements of Table 6 with respect to a cover surface

— down to a distance from the cord surface equal to ±25 % of the cord diameter where there is no transverse reinforcement, and

— down to a distance of ±0,5 mm from the transverse reinforcement where transverse reinforcement is present.

Table 6 — Cover grade (properties of covers)

Grade	Tensile strength min. (ISO 37) MPa	Elongation at break min. (ISO 37) %	Abrasion max. (ISO 4649) mm^3
V	17	350	175

7.6 Adhesion

When tested according to ISO 8094, the adhesion between the covers and the rubber core, and between the covers and the transverse reinforcement, shall be at least 10 N/mm sample width.

7.7 Transverse reinforcements

7.7.1 Breaker

The breaker ply shall consist of threads arranged transverse to the cords within the covers on the carrying and/or pulley side. The threads shall be introduced into the covers either as single threads or as fabric plies bound together by threads.

NOTE 1 The manufacturing process can result in the threads being oval in shape (see Figure 4).

The ratio of the pitch between the threads and their long diameter shall be between 2 and 6 to ensure a good penetration by the rubber, i.e.

$$2 \leq \frac{t}{e} \leq 6$$

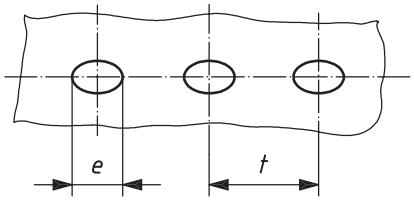


Figure 4 — Cross section of a transverse reinforcement

Breakers shall be applied at a distance, s_4, from the longitudinal cords ranging between 1 mm and 2 mm. The width of the breaker ply shall not be less than the belt width minus 100 mm. The distance between the edge of the breaker and the belt edge shall be at least 10 mm.

When measured according to ISO 2062, the breaking strength of the breaker ply shall be at least 150 N/mm and the elongation at break shall be at least 15 %.

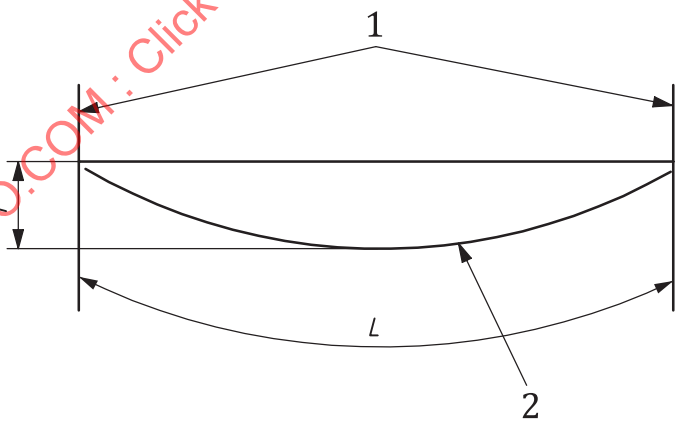
NOTE 2 Testing of the breaker is normally carried out on uncured material. However, if it is agreed to test the breaker taken from a cured belt, samples will need to be taken very carefully to avoid damage as the breaker ply could be in the form of waves.

7.7.2 Weft

Transverse reinforcements as a part of the carcass (weft) are applied at a distance, s_5, of less than 1 mm from the layer of longitudinal cords. The width of the weft shall not be less than the belt width minus 50 mm. The distance between the edge of the weft and the edge of the belt shall be at least 5 mm.

7.8 Troughability

Testing shall be carried out in accordance with ISO 703. The troughability is characterized by the ratio of the deflection, F, to the belt width, L (see Figure 5), as given in Table 7.



Key

1 suspension filament

2 belt sample

Figure 5 — Suspension of sample

Table 7 — Minimum values of *F*/*L* for belt conveyors of three idlers of equal length, according to ISO 703

Troughing angle of side idlers	*F*/*L*
20°	0,08
25°	0,10
30°	0,12
35°	0,14
40°	0,16
45°	0,18
50°	0,20
55°	0,23
60°	0,26

7.9 Tracking

Steel cord conveyor belting, when running on a perfectly aligned conveyor and loaded centrally, shall not deviate from the central track by more than ±40 mm for a belt width up to 800 mm; for belt width over 800 mm, it shall not deviate by more than ±5 % or by more than ±75 mm, whichever is the lesser value.

7.10 Safety requirements

Steel cord conveyor belts for use in underground installations shall comply with the relevant safety requirements specified in EN 14973, following risk assessment, guidance on which is given in EN 14973.

8 Sampling

If a certificate pertaining to the tests required by Clause 7 is to be provided, take a sample between two successive lengths to represent both lengths.

If additional tests are required, take samples of not less than 450 mm length in the full width distributed approximately equally over the belt length up to the number of samples given in Table 8.

Table 8 — Number of samples

Belt length	Number of samples
≤200 m	1 (if requested)
≥200 m ≤500 m	1
>500 m ≤1 000 m	2
>1 000 m ≤2 000 m	3
>2 000 m ≤3 500 m	4
>3 500 m ≤5 000 m	5
>5 000 m ≤7 000 m	6
>7 000 m ≤10 000 m	7
for each addition 5 000 m	1

9 Designation

The symbol ST shall signify the material (steel cords) used for the tension member in the longitudinal direction. This symbol shall be followed by the nominal tensile strength of the belt in newtons per millimetre (N/mm) belt width (see Table 2).

Breaker transverse reinforcements shall be designated by the cover thickness followed by T (for textile) or S (for steel).

Weft transverse reinforcements shall be designated by the letter S (for steel) or T (for textile), after the ST sign, to indicate the material of the weft and the place where it is applied.

EXAMPLE 1 A 1 400 m steel cord conveyor belt (ST) of 1 600 mm width, a minimum tensile strength of 5 000 N/mm belt width, cover thickness of 12 mm on the carrying side and 8 mm on the pulley side, of grade V and conforming the safety requirements of EN 14973:2006, class C2:

1400 m steel cord conveyor belt, ISO 15236-3 - 1600 ST 5000/12 + 8 V/class C2

EXAMPLE 2 A 900 m steel cord conveyor belt (ST) of 1 400 mm width, a minimum tensile strength of 2 500 N/mm belt width, cover thickness of 10 mm on the carrying side and 8 mm on the pulley side, of grade V, with transverse reinforcements (breaker) in the cover thickness of the carrying and pulley sides, consisting of textile material and conforming the safety requirements of EN 14973:2006, class C1:

900 m steel cord conveyor belt, ISO 15236-3 - 1400 ST 2500/10T + 8T V/class C1

EXAMPLE 3 A 1 000 m steel cord conveyor belt (ST) of 800 mm width, a minimum tensile strength of 800 N/mm belt width, cover thickness of 10 mm on the carrying side and 6 mm on the pulley side of grade V, with transverse reinforcements (weft) on the carrying and pulley sides, consisting of steel and conforming the safety requirements of EN 14973:2006, class B1:

1000 m steel cord conveyor belt, ISO 15236-3 - 800 ST S/S 800/10 + 6 V/class B1

10 Ordering data

The minimum requirements of the customers are length, width, breaking strength, cover gauges and cover quality.

For purchasers placing orders with more than one manufacturer or for replacement belting, more detailed information is required for compatibility, such as pitch, number of cords and possibly cord diameter, as well as whether the belt is to be of the standard type or equipped with breaker plies or weft (see Annex A). Attention should be drawn to ISO 15236-2 regarding preferred types.

11 Marking

Steel cord conveyor belts shall be marked with at least the following information:

a) the number and year of this document, i.e. ISO 15236-3:2017;

b) the name of belt manufacturer;

c) the year of manufacture (marking the last two digits of the year, e.g. 17 to denote 2017, is acceptable);

d) the belt identification number, with no more than five digits;

e) the nominal tensile strength, expressed in N/mm;

f) the thickness of the top and bottom covers, expressed in millimetres, together with the letter “T” for textile reinforcement or “S” for steel breaker or weft.

Annex A
(informative)

Helpful information to be supplied by the purchaser

A.1 Applicability

When ordering, belting purchasers should define their requirements by reference to Clause 10 (ordering data).

A.2 Replacement belting

When the belt is to be replaced on an existing conveyor, the following information should be supplied:

a) details of existing belt, i.e. cord diameter, pitch, no. of cords, cover thickness, transverse reinforcement, cover grade;

b) belt width, in millimetres;

c) belt speed, in metres per second;

d) pulley diameters, in millimetres, indicating any that are crowned;

e) method of take-up and amount available;

f) type of drive, including coupling and configuration of drive;

g) whether drive pulleys are lagged or bare;

h) pitch, length and angle of carrying idlers;

i) profile sketch, indicating position of drive, take-up, tripper, and vertical/horizontal curve radii;

j) belt length, in metres;

k) type of belt joint;

l) motor power installed;

m) type of start;

n) safety category required according to EN 14973;

o) head and tail transition distance;

p) rip prevention/detection system.

A.3 Additional information for new installation

Where applicable and if possible, the following additional information should be supplied:

a) material to be conveyed;

b) conditions — wet, dry, sticky, greasy, abrasive; if hot or cold, and stating temperature, if known, or describing conditions, whether cleaners are required;

c) bulk density of material;