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Conveyor belts — Determination of elastic and permanent elongation and calculation of elastic modulus

Courroies transporteuses — Détermination de l'allongement élastique et rémanent et calcul du module d'élasticité

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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).

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 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.

The committee responsible for this document is ISO/TC 41 *Pulleys and belts (including veebelts)*, Subcommittee SC 3, *Conveyor belts*.

This third edition cancels and replaces the second edition (ISO 9856:2003), of which it constitutes a minor revision. It also incorporates the amendment ISO 9856:2003/Amd 1:2012.

The normative references have been updated.

Introduction

This International Standard is used in a number of situations where the permanent elongation of the conveyor belt after mechanical conditioning is of some practical relevance and in particular in the implementation of ISO 3870 and the application of ISO 5293.

Conveyor belts — Determination of elastic and permanent elongation and calculation of elastic modulus

1 Scope

This International Standard specifies a method for determining the elastic and permanent elongation of a conveyor belt and the calculation of the elastic modulus.

It is not applicable or valid for light conveyor belts as described in ISO 21183-1.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for 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 282, *Conveyor belts — Sampling*

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

ISO 18573, *Conveyor belts — Test atmospheres and conditioning periods*

3 Terms and definitions

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

3.1
tensile strength
greatest measured force during the tensile test divided by the width of the test piece

Note 1 to entry: It is expressed in newtons per millimetre.

Note 2 to entry: See ISO 283 for tensile test.

3.2
nominal tensile strength
T
specified minimum value of the *tensile strength* (3.1)

Note 1 to entry: It is expressed in newtons per millimetre.

3.3
upper reference force
F_U
force equivalent to 10 % of T (3.2)

Note 1 to entry: It is expressed in newtons per millimetre.

3.4
lower reference force
F_L
force equivalent to 2 % of T (3.2)

Note 1 to entry: It is expressed in newtons per millimetre.

3.5
specific force range factor
ΔF
specific force range applied during the test, i.e. the *upper reference force* (3.3) minus the *lower reference force* (3.4):

$$\Delta F = F_U - F_L$$

Note 1 to entry: It is expressed in newtons per millimetre.

3.6
permanent elongation
Δl_p
non-recoverable change in length of the test piece after defined loading cycles

Note 1 to entry: It is expressed in millimetres.

3.7
elastic elongation
Δl_e
recoverable change in length of the test piece after defined loading cycles

Note 1 to entry: It is expressed in millimetres.

Note 2 to entry: The recovery from extension may be instantaneous or time-dependent, or a combination of both.

3.8
reference length
l_0
initial length of the test piece

Note 1 to entry: It is expressed in millimetres.

3.9
permanent strain
ε_{perm}
permanent elongation, Δl_p, (3.6) expressed as a percentage of the *reference length*, l_0 (3.8)

Note 1 to entry: This term is often referred to as “permanent stretch” in conveyor belt technology.

3.10
elastic strain
ε_{elast}
elastic elongation, Δl_e, (3.7) expressed as a percentage of the *reference length*, l_0 (3.8)

Note 1 to entry: This term is often referred to as “elastic stretch” in conveyor belt technology.

3.11
elastic modulus
M
ΔF (3.5) divided by the fractional *elastic elongation* (3.7) at the end of the specified number of cycles

Note 1 to entry: It is expressed in newtons per millimetre.

Note 2 to entry: This definition of the term deviates from that normally used in engineering, in which the modulus is expressed in units of stress (i.e. a force per unit of cross-section) and is represented by the symbol E.

4 Principle

A test piece, cut from the full thickness of the conveyor belt in the longitudinal direction, is subjected to a force that varies sinusoidally between defined limits. After 200 cycles, the amount of permanent elongation of the test piece and the amount of elastic elongation produced by the force differential are recorded from a force-elongation graph.

The special application conveyor belts may be used with higher elongation in the tensile member. For these belts, the permanent elongation measured according to the stated test procedure does not allow a conclusion regarding the permanent elongation of the belt in real-life operation. A higher number of load cycles (jointly agreed upon by the supplier and the customer) can be of help.

5 Apparatus

5.1 Dynamic tensile testing machine, of appropriate capacity to enable up to at least of the nominal tensile breaking load of the conveyor belt to be applied and with a force measuring system in accordance with ISO 7500-1, class of machine 3 or better (e.g. class 2).

5.2 Extensometer, with a measuring length of at least 100 mm and accurate to 0,1 mm or more.

5.3 Recording device, to record the graph of the applied tensile stress as a function of actual elongation.

6 Sampling

Select a sample of conveyor belt in accordance with ISO 282 of sufficient size to enable all three test pieces described in 7.1 to be obtained. One test piece shall be taken from each edge of the belt and one test piece shall be taken from the middle of the belt. The sample shall be taken at least five days after manufacture.

7 Test pieces

7.1 Number, shape and dimensions

Cut three rectangular test pieces, each 50 mm wide × at least 300 mm long (plus the necessary clamping length at each end of the test piece) in the longitudinal direction from the full thickness of the conveyor belt.

7.2 Preparation

Remove the covers from each test piece so that the thickness of the remaining cover is between 0,5 mm and 1 mm.

8 Conditioning

Condition the test pieces in accordance with ISO 18573.

9 Procedure

Place the ends of the test piece between the jaws or clamps of the tensile testing machine (5.1) so that it is held securely and the free length between the faces of the jaws is at least 300 mm.

Apply an initial force to the test piece equal to 0,5 % of the nominal tensile strength, *T*, multiplied by the test piece width in millimetres.

Position the two grids of the extensometer (5.2) on the axis of the test piece with a known reference length of at least 100 mm.

Set the graphical recorder (5.3) to zero elongation.

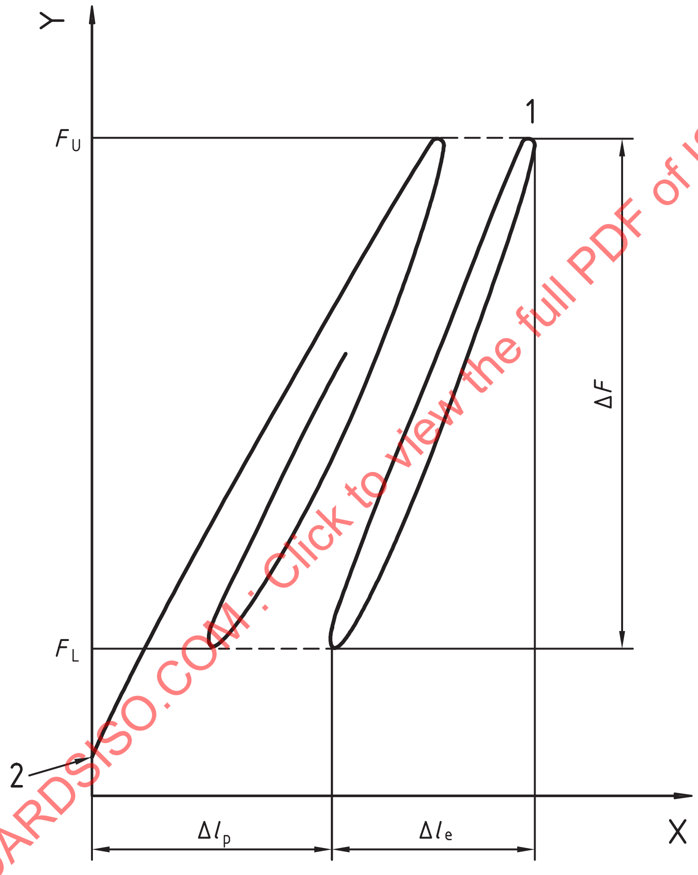
Apply force to the test piece approximately sinusoidally and at a frequency of 0,1 Hz between the upper and lower reference forces as defined in 3.3 and 3.4.

Record graphically at least the first and the 200th cycles (see Figure 1).

From the graph obtained (see Figure 1), record

— the value of ΔF of test piece width, in newtons per millimetre, and

— the value of Δl_e and Δl_p at the 200th cycle.



Key

1 200th cycle

2 initial force

X actual elongation

Y force applied, N/mm

Figure 1 — Variation in extension of a test piece in relation to cyclic applications of a load

10 Calculation and expression of results

10.1 Calculate the percentage permanent elongation, ε_{perm}, of the belt in accordance with Formula (1):

$$\varepsilon_{perm} = \frac{\Delta l_p}{l_o} \times 100 \tag{1}$$

10.2 Calculate the percentage elastic elongation, ε_{elast}, of the belt in accordance with Formula (2):

$$\varepsilon_{elast} = \frac{\Delta l_e}{l_o} \times 100 \tag{2}$$

10.3 Calculate the elastic modulus, M, of the belt in accordance with Formula (3) or Formula (4) and express the results in newtons per millimetre width of belt, or multiples thereof:

$$M = \frac{\Delta F}{\varepsilon_{elast}} \times 100 \tag{3}$$

or

$$M = \frac{\Delta F \times l_o}{\Delta l_e} \tag{4}$$

10.4 Calculate the arithmetic mean of the three results so obtained for each of the values in 10.1, 10.2 and 10.3, rounding the value to the first decimal place.

11 Test report

The test report shall contain the following information:

a) identification of the belt tested;

b) a reference to this International Standard, i.e. ISO 9856;

c) the results of the test: the individual values and the arithmetic mean values;

d) the conditioning period and the conditioning atmosphere;

e) the temperature and the relative humidity in the test room throughout the test;

f) the details of any deviation from this International Standard or from the International Standards to which reference is made, and details of any operations regarded as optional.

