Light conveyor belts — Method of test for the determination of the relaxed elastic modulus

The European Standard EN 1723:1999 has the status of a British Standard

ICS 53.040.20

National foreword

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 6, an inside back cover and a back cover.

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English version

Light conveyor belts — Method of test for the determination of the relaxed elastic modulus

Courroies transporteuses légères — Méthode d'essai pour la détermination du module d'élasticité relaxé

Leichte Fördergurte — Prüfverfahren zur Bestimmung des relaxierten Elastizitätsmoduls

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CEN

European Committee for Standardization

Comité Européen de Normalisation

Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 1723:1999 E

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 188, Conveyor belts, the Secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2000, and conflicting national standards shall be withdrawn at the latest by February 2000.

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Introduction

Many applications for light conveyor belts require that the belt is initially tensioned and there is no subsequent change in belt length by adjustment of any rollers. In such cases the tensioning force in the belt changes throughout the life of the belt because of two effects: both permanent stretch and relaxation of the belt changing its real elastic modulus. It is vital to have a means of establishing the way in which the tensioning forces will change and this test applies to a cyclic stretching between two defined states of elongation over a large number of cycles. It has been found experimentally that the tensioning force drops in an exponential way. It is possible to measure the tensioning force and then to calculate what is herein defined as the "relaxed elastic modulus". It is important to note that this is not a true elastic modulus, because it includes an element of permanent stretch but, except in cases where the permanent stretch is relatively large, it is a measure of great practical value in determining final tensioning forces. This standard is designed to meet the requirements for such applications.

1 Scope

This European Standard specifies a test method for the determination of the relaxed elastic modulus of light conveyor belts as defined by EN 873 or other conveyor belts where ISO 9856 is unsuitable.

2 Normative references

This European Standard incorporates by dated or undated references, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 873, *Light conveyor belts — Principal characteristics and applications.*

EN 10002-2, *Metallic materials — Tensile testing — Part 2: Verification of the force measuring system of the tensile testing machines.*

ISO 471, *Rubber — Temperatures, humidities and times for conditioning and testing.*

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications.*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tensile testing machines.*

ISO 9856, *Conveyor belts — Determination of elastic modulus.*

3 Definitions and symbols

For the purposes of this standard the following apply.

3.1

elastic modulus

1) (in conveyor belt technology). A force per unit of width of a conveyor belt. It is expressed in newtons per millimetre width of belt and is represented in ISO 9856 by the symbol M.

NOTE This definition of the term deviates from that normally used in engineering which is expressed in units of stress, i.e. a force per unit of cross section and is represented by the symbol E; (see for example ISO 527-4).

2) (in light conveyor belt technology). The force in newtons per unit of width required to extend a representative test piece of light conveyor belting by 1 % of its original length. The force is represented by the symbol k and consequently the **elastic modulus** is represented by the symbol $k_{1\,\%}$. This value is also called the "tensile force for 1 % elongation per unit of width" or "$k_{1\,\%}$ value". It is expressed in newtons per millimetre

NOTE In EN 10002-1:1991, the symbol k is used to represent the coefficient of proportionality.

3.2

relaxed elastic modulus

used in light conveyor belt technology to describe the elastic modulus of a light conveyor belt after being cycled between predetermined limits of extension for 500 cycles

NOTE The $k_{1\,\%}$ value of a new conveyor belt is higher than that of a used conveyor belt in which relaxation has taken place in service. The relaxation takes place following an exponential function.

The following symbols are also used in this standard:

F_A, F_B are the maximum and minimum tensile forces respectively in the test piece in newtons;

F'_A, F'_B are the specific values of F_A, F_B referred to the width of the test piece in newtons per millimetre;

- a is the value in newtons per millimetre of $k_{1\,\%}$ for $z = 1$;
- b is the manufactured width of the conveyor belt in millimetres:
  [in equations (4) and (5), b is the slope of the straight line];
- r is the correlation coefficient;
- x is the variable in the equation of the straight line;
- y is the value of the equation of the straight line;
- z is the number of cyclic elongations.

4 Principle

A test piece, cut from the full thickness of the conveyor belt in the longitudinal direction, is exposed to a cyclic elongation between two defined limits and the tensile force is recorded as a function of the number of cycles. From that graph, the relaxed elastic modulus is determined by calculation through a logarithmic regression.

5 Apparatus

Tensile testing machine, capable of applying load suitable for the strength of the test piece and with a force measuring system in accordance with EN 10002-2, Class of machine 3 or better (e.g. Class of machine 2) as well as capable of applying the load in displacement-controlled cycles of ±5 mm and with a frequency of 0.5 Hz (this frequency being realizable also with older, mechanically controlled dynamometers).

6 Test piece

6.1 Shape, dimensions, number and selection

Cut from the full thickness of the conveyor belt in the longitudinal direction five rectangular test pieces each (50 ± 0,5) mm wide × (500 plus twice the length necessary for clamping in the jaws) mm long. Select the test pieces from the conveyor belt at places as shown in Figure 1.

6.2 Conditioning

The test pieces shall be conditioned at (23 ± 2) °C and a relative humidity of (50 ± 5) % in accordance with ISO 471 and ISO 554.

The climatizing time shall be:

For light conveyor belts containing materials with a low absorption of moisture, e.g. polyester, 24 h.

For light conveyor belts containing materials with a high absorption of moisture e.g. cotton or polyamide, 48 h.

7 Procedure

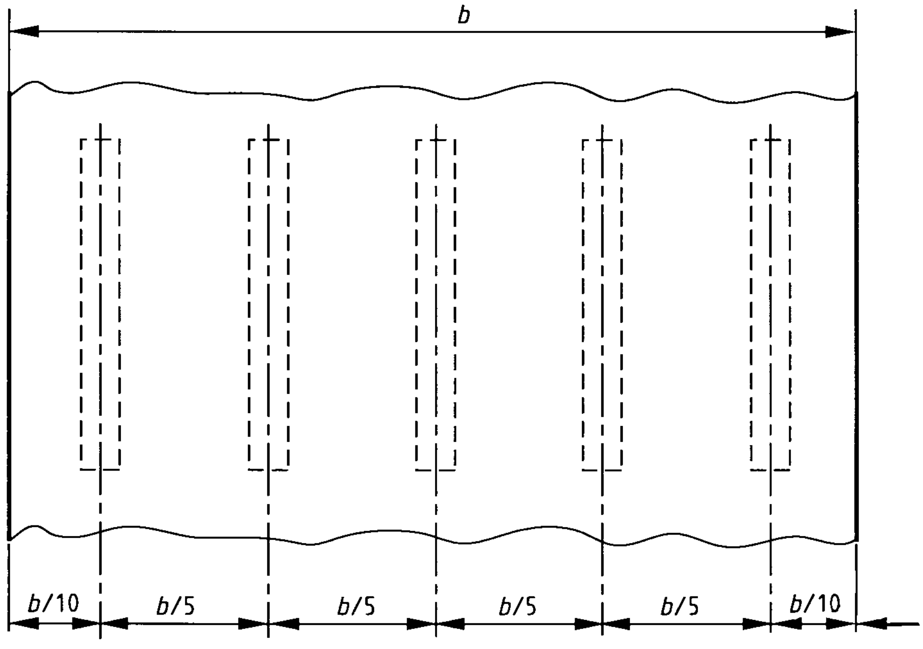
The test pieces shall not be tested earlier than five days after manufacture of the conveyor belt.

The test shall be carried out with each of the test pieces defined in **6.1**.

Place the ends of the test piece between the jaws of the tensile testing machine in such a way that the test piece is straight without using force. The free length between the jaws shall be 500 mm ± 1 mm. There shall be no slippage of the test piece in the jaws during the test.

NOTE 1 Slippage can be minimized by rubbing rosin on the portion of the test piece that will be in the jaws, removing any excess rosin and enclosing both sides of the rosin-coated test piece with coarse emery cloth. The emery cloth should be folded over the ends of the test piece with the coarse side of the cloth next to the rosin-coated surfaces.

Elongate the test piece cyclically between 1 % and 2 % (5 mm and 10 mm) at a frequency of 0,5 Hz.



b = manufactured width of the conveyor belt

Figure 1 — Distribution of test piece selection

NOTE 2 The same effect will be realized if the test piece is given an initial elongation of 1,5 %, corresponding to 7,5 mm and a cyclic alteration of the elongation of ±0,5 %, corresponding to ±2,5 mm, is superposed at the same frequency. In both cases the average speed of deformation in the test piece will be 5 mm/s (= 300 mm/min).

In cases of conveyor belts containing reinforcing elements with a high elastic modulus (e.g. with reinforcing elements of Aramid threads), the cyclic elongation of the test piece shall take place between 0,5 % and 1 % (2,5 mm and 5 mm) at the same frequency of 0,5 Hz.

Record the tensile force during 500 cyclic elongations as a function of the number of cycles. At the end of the test measure the permanent elongation by reducing the tensioning force to zero, and measuring the distance between the jaws. If this elongation is equal to or exceeds 1 % of the initial length, then this test is unsuitable for such a belt type and ISO 9856 shall be used instead.

8 Calculation and expression of results

Read the forces F_A and F_B for the number of cyclic elongations $z = 250$, $z = 350$ and $z = 500$ from the graph following Figure 2.

Refer all these forces to the unit of belt width (50 mm):

$$F'_A = \frac{F_A}{50} \text{ in newtons per millimetre} \quad [1]$$

$$F'_B = \frac{F_B}{50} \text{ in newtons per millimetre} \quad [1]$$

Calculate the elastic moduli belonging to F'_A and F'_B.

In case of having applied a cyclic elongation between 1 % and 2 %, calculate the elastic modulus from:

$$k_{1\,\%} = \frac{F'_A + F'_B}{2 \cdot 1{,}5} \text{ in newtons per millimetre} \quad [2]$$

In case of having applied a cyclic elongation between 0,5 % and 1 %, calculate the elastic modulus from the following equation:

$$k_{1\,\%} = \frac{F'_A + F'_B}{2 \cdot 0{,}75} \text{ in newtons per millimetre} \quad [3]$$

From the three calculated $k_{1\,\%}$, values and the corresponding numbers of cyclic elongations, the equation of a straight line of the form:

$$y = a + bx \quad [4]$$

is determined, with which a logarithmic regression is carried out subsequently.

For that, a calculator is used which provides statistic functions. The x-values of the number couples to put in are the numbers of cyclic elongations given as natural logarithms (ln z). The y-values are the corresponding calculated $k_{1\,\%}$ values.

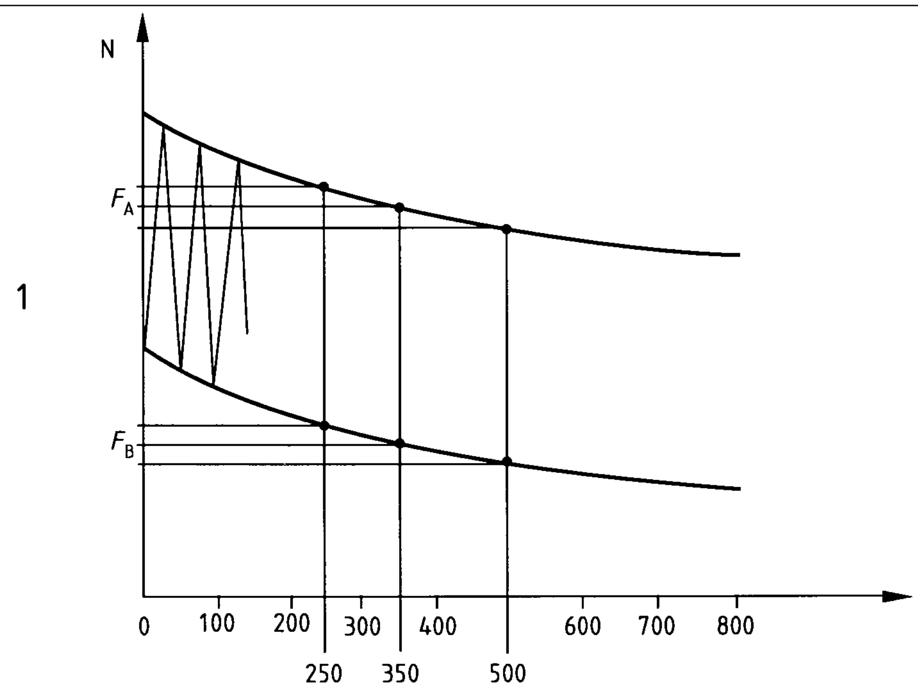
Therefore, equation [4] reads:

$$k_{1\,\%} = a + b \cdot \ln z \quad [5]$$

where

b is the slope of the straight line; and

a is $k_{1\,\%}$ for $z = 1$.



① = Tensile force F

② = Number of cycles z

Figure 2 — Tensile force as a function of number of cyclic elongations

Both values, as well as the correlation coefficient r, are determined by the calculator.

NOTE The correlation coefficient r of the straight line should be as high as possible. Ideal would be 1,0; values between 0,8 and 1,0 are sufficiently high. With $r < 0,7$, the test should be repeated and the calculation should be done with larger numbers z of cyclic elongations.

After that, by means of the found values for a and b and with equation [5] the relaxed $k_{1\,\%}$ value is calculated by putting in for z a number of 43 200 cyclic elongations, corresponding to a testing time of 24 h at a frequency of 0,5 Hz, see Figure 3.
(Numerically: In 43 200 = 10,67.)

Calculate the individual relaxed $k_{1\,\%}$ values for all five test pieces and determine the arithmetical mean of the five values.

9 Test report

The test report shall include at least the following information:

a) a complete designation of the tested conveyor belt material and the manufacturing date;

b) reference to this European Standard;

c) test room temperature and relative humidity;

d) conditioning period;

e) procedure applied (elongation between 1 % and 2 % or between 0,5 % and 1 %);

f) results of the test (following clause **8**);

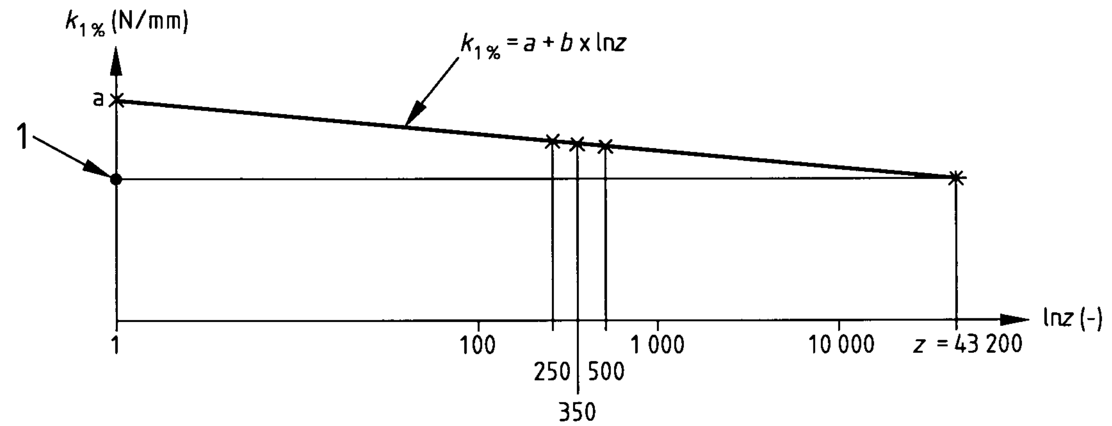
g) date of test.

Annex A (informative)

Bibliography

ISO 527-4, *Plastics — Determination of tensile properties — Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites.*

EN 10002-1:1991, *Metallic materials — Tensile testing — Part 1: Method of test (at ambient temperature).*



① = $k_{1\,\%}$ relaxed

Figure 3 — Determination of the relaxed $k_{1\,\%}$ value

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