*भारतीय मानक*
*Indian Standard*

IS 16384 : 2017
ISO 21181 : 2013

# हल्की कन्वेयर बेल्ट — आराम से लोचदार मापांक के निर्धारण

# Light Conveyor Belts — Determination of the Relaxed Elastic Modulus

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**Price Group 4**

Transmission Devices Sectional Committee, PGD 33

NATIONAL FOREWORD

This Indian Standard which is identical with ISO 21181 : 2013 'Light conveyor belts — Determination of the relaxed elastic modulus' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Transmission Devices Sectional Committee and approval of the Production and General Engineering Division Council.

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminology and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a)  Wherever the words 'International Standard' appear  referring to this standard, they should be read as 'Indian Standard'.

b)  Comma (,) has been used as a decimal marker while in Indian Standards,  the current practice is to use a point (.) as the decimal marker.

The technical committee has reviewed the provisions of the  following International Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

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| International Standard | Title |
| --- | --- |
| 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 9856 | Conveyor belts — Determination of elastic and permanent elongation and calculation of elastic modulus |
| ISO 18573 | Conveyor belts — Test atmospheres and conditioning periods |
| ISO 21183-1 | Light conveyor belts — Part 1: Principal characteristics and applications |

## *Indian Standard*

# LIGHT CONVEYOR BELTS — DETERMINATION OF THE RELAXED ELASTIC MODULUS

## 1 Scope

This International Standard specifies a test method for the determination of the relaxed elastic modulus of light conveyor belts according to ISO 21183-1 or other conveyor belts where ISO 9856 is not applicable.

## 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 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 9856, *Conveyor belts — Determination of elastic and permanent elongation and calculation of elastic modulus*

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

ISO 21183-1, *Light conveyor belts — Part 1: Principal characteristics and applications*

## 3 Terms and definitions

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

**3.1**
**elastic modulus**
<conveyor belt technology> force per unit of width of a conveyor belt

Note 1 to entry: It is expressed in newtons per millimetre width of belt and is represented in ISO 9856 by the symbol $M$.

Note 2 to entry: 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 represented by the symbol $E$ (see, for example, ISO 527-4).

**3.2**
**elastic modulus**
<light conveyor belt technology> force in newtons per unit of width required to extend a representative test piece of light conveyor belting by 1 % of its original length

Note 1 to entry: 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 2 to entry: In EN 10002-1:2001, the symbol $k$ is used to represent the coefficient of proportionality.

**3.3**
**relaxed elastic modulus**
<light conveyor belt technology> elastic modulus of a light conveyor belt after being cycled between predetermined limits of extension for 500 cycles

Note 1 to entry: 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.

## 4   Symbols

For the purposes of this document, the following symbols apply.

$F_A$, $F_B$        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 conveyor belt, in millimetres;

$r$              is the correlation coefficient;

$x$              is the variable in equation of straight line;

$y$              is the value of equation of straight line;

$z$              is the number of cyclic elongations.

## 5   Principle

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

## 6   Apparatus

**6.1    Tensile testing machine**, capable of applying a load suitable for the strength of the test piece and with a force measuring system in accordance with ISO 7500-1:2004, class of machine 3 or better (e.g. class of machine 2), and also 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).

## 7   Test pieces

### 7.1   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 and having a length of 500 mm plus twice the length necessary for clamping in the jaws. Select the test pieces from the conveyor belt in accordance with Figure 1. The test piece shall not be tested sooner than five days after manufacture.

Dimensions in millimetres
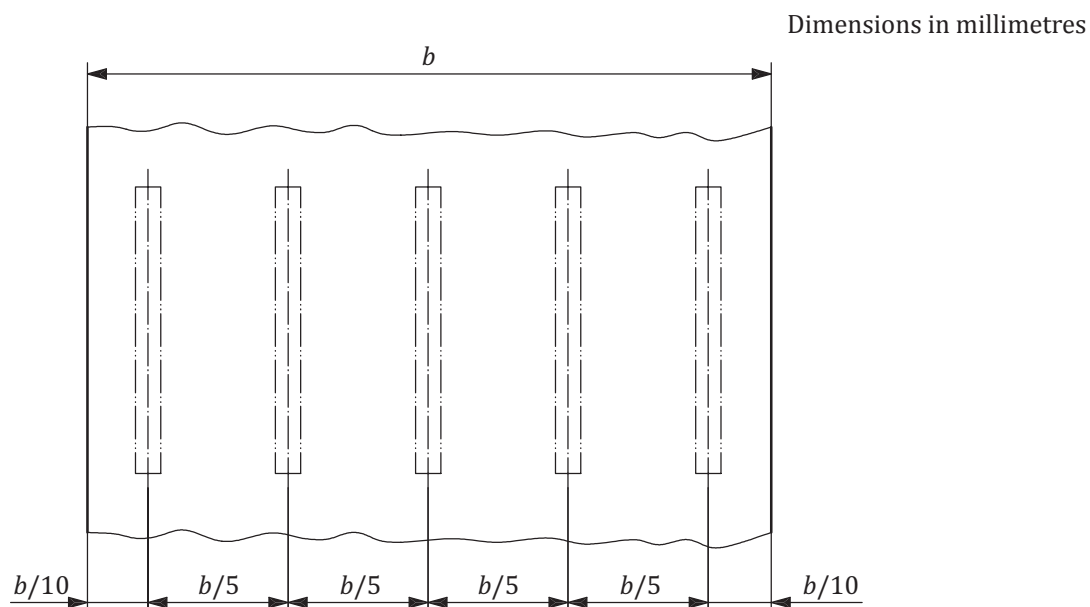


**Figure 1 — Distribution of test piece selection**

## 7.2 Conditioning

Before testing, condition the test pieces in accordance with ISO 18573, Atmosphere B, for 24 h, except that, if the light conveyor belt (as specified in ISO 21183-1 ) consists of materials with a high absorption of moisture, e.g. cotton or polyamide, condition the test piece for 48 h.

## 8 Procedure

Place the ends of the test piece between the jaws of the tensile testing machine (6.1) such that the test piece is straight without using force. Ensure that the free length between the jaws is 500 mm ± 1 mm and that there is no slippage of the test piece in the jaws during the test.

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, either

a) between 1 % and 2 % (5 mm and 10 mm) at a frequency of 0,5 Hz, or

b) if the conveyor belt contains reinforcing elements with a high elastic modulus (e.g. with reinforcing elements of aramid threads), between 0,5 % and 1 % (2,5 mm and 5 mm) at the same frequency of 0,5 Hz.

NOTE    For a), 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. The average speed of deformation in the test piece will be 5 mm/s ( = 300 mm/min).

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, this indicates that the method is unsuitable for such a belt type; in which case, use the method according to ISO 9856 instead.
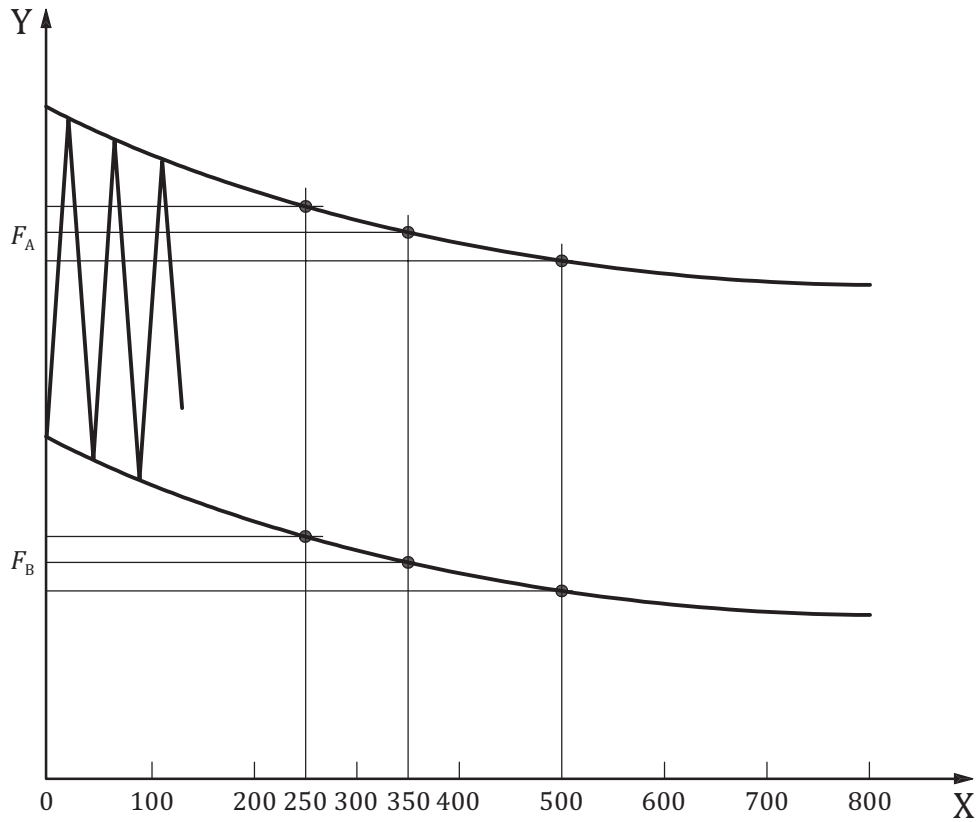
**Key**

X    number of cycles, $z$

Y    tensile force, $F$, N

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

## 9    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 shown in <u>Figure 2</u>.

Divide all of these forces by belt width (50 mm) to give the elastic moduli, as follows:

$$F_A' = \frac{F_A}{50} \ \text{N/mm} \tag{1a}$$

$$F'_B = \frac{F_B}{50} \text{ N/mm} \tag{1b}$$

If a cyclic elongation between 1 % and 2 % has been applied, calculate the elastic modulus from the following formula:

$$k_{1\%} = \frac{F'_A + F'_B}{2 \times 1,5} \text{ N/mm} \tag{2}$$

If a cyclic elongation between 0,5 % and 1 % has been applied, calculate the elastic modulus from the following formula:

$$k_{1\%} = \frac{F'_A + F'_B}{2 \times 0,75} \text{ N/mm} \tag{3}$$

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

$$y = a + cx \tag{4}$$

and subsequently carry out a logarithmic regression.

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

Therefore, Formula (4) becomes:

$$k_{1\%} = a + (c \times \ln z) \tag{5}$$

where

    $c$    is the slope of the straight line;

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

Determine both values and the correlation coefficient, $r$, by calculator.

The correlation coefficient $r$ of the straight line should be as high as possible. Ideally, it would be 1,0, although values between 0,8 and 1,0 are sufficiently high. If $r < 0,7$, the test should be repeated and the calculation carried out with larger numbers of cyclic elongations, $z$.

By means of the found values for $a$ and $c$ and with Formula (5), calculate the relaxed $k_{1\%}$ value by putting in a value for $z$ of 43 200 cyclic elongations, corresponding to a testing time of 24 h at a frequency of 0,5 Hz (see Figure 3). (Numerically, ln 43 200 = 10,67.)

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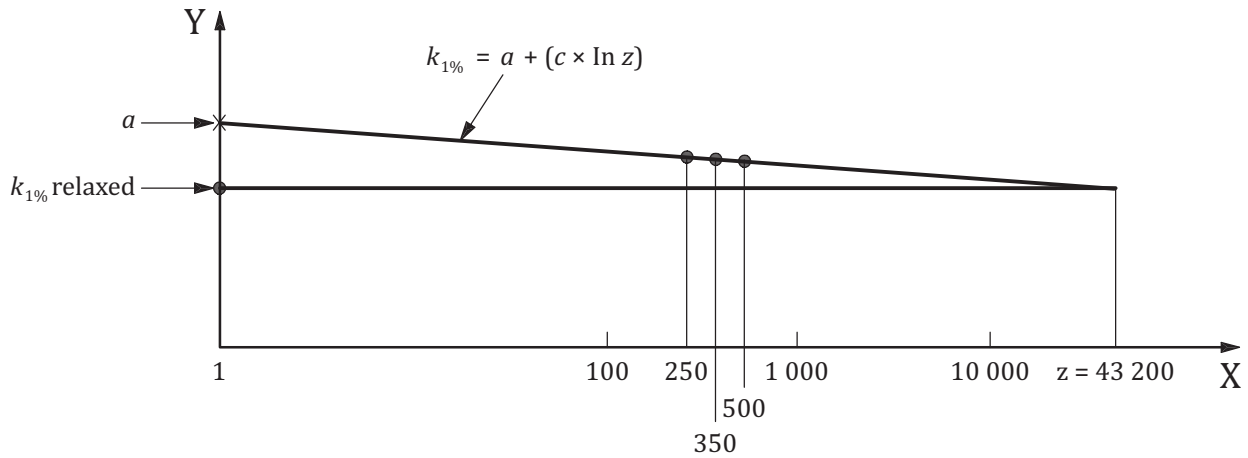
Key

X $\ln z$ (−)

Y $k_{1\%}$, N/mm

a $k_{1\%}$ for Z = 1

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

## 10 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 International Standard, i.e. ISO 21181;

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, in accordance with Clause 9;

g) date of the test.

# Bibliography

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

[2]     EN 10002-1:2001, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

**Amendments Issued Since Publication**

| Amend No. | Date of Issue | Text Affected |
|---|---|---|
| | | |
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