**SLOVENSKI STANDARD**
**SIST-TS CEN/TS 15963:2010**

**01-april-2010**

**Bitumen in bitumenska veziva - Določanje temperature lomne žilavosti s tritočkovnim upogibnim preskusom**

Bitumen and bituminous binders - Determination of the fracture toughness temperature by a three point bending test on a notched specimen

Bitumen und bitumenhaltige Bindemittel - Bestimmung der Bruchwiderstandstemperatur mittels eines gekerbten Drei-Punkt- Biegeversuches



Bitumes et liants bitumineux - Détermination de la température de résistance à la rupture par un essai de flexion 3 points sur un barreau entaillé



**Ta slovenski standard je istoveten z: CEN/TS 15963:2010**

**ICS:**

| | | |
|---|---|---|
| 75.140 | Voski, bitumni in drugi naftni proizvodi | Waxes, bituminous materials and other petroleum products |
| 91.100.50 | Veziva. Tesnilni materiali | Binders. Sealing materials |

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TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

TECHNISCHE SPEZIFIKATION

**CEN/TS 15963**

January 2010

ICS 91.100.50

English Version

# Bitumen and bituminous binders - Determination of the fracture toughness temperature by a three point bending test on a notched specimen

Bitumes et liants bitumineux - Détermination de la température de résistance à la fissuration par un essai de flexion 3 points sur un barreau entaillé

Bitumen und bitumenhaltige Bindemittel - Bestimmung der Bruchwiderstandstemperatur mittels eines Drei-Punkt-Biegeversuches an einem gekerbten Probekörper

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# Foreword

This document (CEN/TS 15963:2010) has been prepared by Technical Committee CEN/TC 336 "Bituminous binders", the secretariat of which is held by AFNOR.

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## 1 Scope

This Technical Specification specifies a method for the determination of the Fracture Toughness temperature, $T_{FT}$, of bituminous binders by means of a three point bending test on a notched binder sample.

**WARNING — The use of this Technical Specification can involve hazardous materials, operations and equipment. This Technical Specification does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this Technical Specification to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.**

## 2 Normative references

The following referenced documents are indispensable for the application 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.

EN 58, *Bitumen and bituminous binders — Sampling bituminous binders*

EN 12594, *Bitumen and bituminous binders — Preparation of test samples*

## 3 Terms and definitions



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



**3.1**
**maximum force**
***F***
highest force measured during the bending test

NOTE 1 The test is done in the brittle state or close to that, so that the maximum force is considered as the onset of the crack propagation.

NOTE 2 Force is expressed in Newtons (N).

**3.2**
**displacement at maximum force**
***D***
bending of the test beam from the beginning of the test (from the zero point) to the break point

NOTE Displacement is expressed in millimetres (mm).

**3.3**
**work**
***W***
area under the force-displacement curve from the beginning of the test to the break of the sample, i.e. at the maximum force

NOTE Work is expressed in Newtons · metres (N·m) or in Joules (J).

**3.4**
**Fracture Toughness temperature**
$T_{FT}$
temperature at which the displacement at the maximum force is 0,3 mm (from the zero point)

NOTE Fracture Toughness temperature is expressed in degrees Celsius (°C).

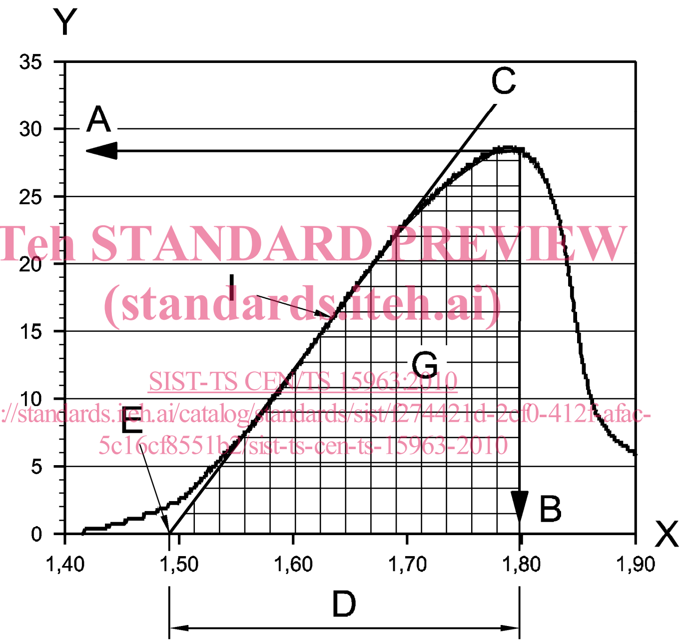
**3.5**
**initial stiffness**
***S***
value calculated as the tangent of the force-displacement curve at the inflection point

NOTE 1 See Figure 1.

NOTE 2 Stiffness is expressed in Newtons per millimetre (N/mm).

**3.6**
**zero point**
intersection of the x-axis and the tangent of the force-displacement curve at the inflection point

Figure 1 presents an example of the Force versus displacement curve at a temperature $T$ close to $T_{FT}$.






**Key**

X displacement, in millimetres (mm)

Y force, in Newtons (N)

A maximum force (defined as *F)*

B X point at maximum force

C tangent at the inflection point

D displacement at maximum force, (*D* = B - E*)*

E zero point

G work (defined as *W)*

I inflection point of *F* versus displacement

**Figure 1 — Example of a Force versus displacement curve at temperature *T* (close to $T_{FT}$)**

# 4 Principle

The notched three point bending test is used to measure cracking perfomance of unmodified and modified bituminous binder samples. The test sample is a beam with a notch in the middle of one side of the beam. The sample is conditioned in a temperature controlled bath. The beam is placed on two supports with the notch facing downwards and a vertical downward force is applied on the middle of the upper face of the sample. The beam is loaded until failure with a specified displacement rate, whereby force is recorded versus displacement.

NOTE 1 The fracture properties of bituminous binders are strongly dependent on test temperature, loading rate and sample preparation method.

NOTE 2 This test is based on the work done by S. Hesp for the Ministry of Transportation in Ontario, Canada [1].

# 5 Apparatus

## 5.1 Testing apparatus

### 5.1.1 Tension-compression device

A universal tension-compression device, which is capable of sustaining a constant, predetermined displacement rate.



### 5.1.2 Bending rig

A bending rig consisting of two cylindrical specimen supports, a cylindrical-nosed shaft to apply the load to the mid-point of the test specimen and a load cell mounted in line with the loading shaft.



The dimensions and tolerances of the loading frame are given in Table 1.

### 5.1.3 Loading system

A loading system, which is capable of applying a rate of displacement of 0,01 mm/s. The specified displacement rate shall fluctuate by no more than ± 10 % over time. The maximum stroke of the instrument shall be at least 20 mm for this test.

### 5.1.4 Loading shaft

A loading shaft, which is continuous and in line with the load cell and deflection measuring transducer. The T-shape shaft shall have a cylindrical-shaped loading pin in the end. The diameter of the pin shall be (10,0 ± 0,1) mm.

### 5.1.5 Load cell

A load cell having a minimum capacity of no less than 500 N and an accuracy of ± 1 % above 5 N with a minimum resolution of at least 100 m·N is required. The load cell shall allow the measurement of the force at any time during the test.

### 5.1.6 LVD-transducer

An LVD transducer or other suitable device to measure the deflection of the sample is necessary. It shall have a linear range of at least 5 mm with an accuracy of 2 µm. The deflection may be measured using this separate transducer or by measuring the vertical movement of the tension/compression device.

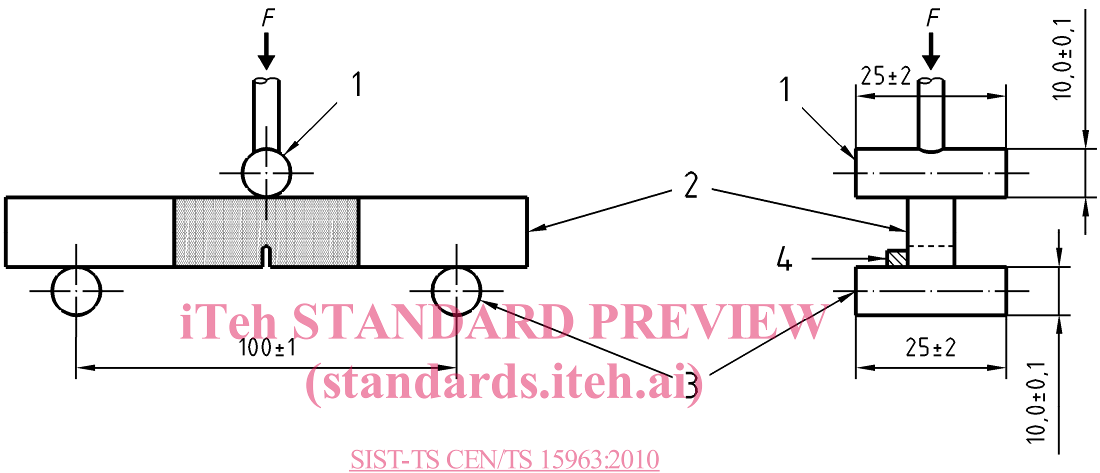
#### 5.1.7 Specimen supports

Specimen supports which shall consist of two non-corrosive metal half-rounds or cylinders with a diameter of (10,0 ± 0,1) mm that are spaced (100 ± 1) mm apart (cylinder centre point to cylinder centre point). The specimen shall be placed perpendicular to the supports and the loading pin. To facilitate that, two vertical alignment pins of 2 mm to 4 mm in diameter can be provided at the back of each support. A schematic diagram of the sample supports is shown on Figure 2.

**5.1.8 Ventilated oven**, capable of maintaining a temperature up to 200 °C, with an accuracy of ± 1 °C.

The specified temperature shall only be assessed in the surroundings of the sample (see 6.3).

Dimensions in millimetres






**Key**

1 cylindrical loading shaft pin

2 specimen (see details on Figure 3)

3 specimen supports

4 alignment pin

*F* force applied

**Figure 2 — Bending rig**

**Table 1 — Measurement and tolerances of the rig**

| Dimension | Size<br>mm | Tolerance<br>mm |
|---|---|---|
| Loading shaft pin length | 25 | ± 2 |
| Loading shaft diameter | 10,0 | ± 0,1 |
| Specimen support length | 25 | ± 2 |
| Specimen support diameter | 10,0 | ± 0,1 |
| Specimen support span | 100 | ± 1 |

### 5.1.9 Temperature measurement device

A calibrated temperature transducer capable of measuring the temperature with the accuracy of ± 0,1 °C over the range of – 40,0 °C to 0,0 °C. The temperature measuring head shall be mounted in the near vicinity of the specimen, at a distance of not more than 25 mm from the middle of the specimen.

### 5.1.10 Liquid bath

A liquid bath shall be capable of maintaining the required test temperature near the test specimen within ± 0,2 °C during the isothermal conditioning and the test procedure, enabling to reach the lower temperature required for testing the specimen.

Bath liquid shall not affect the properties of the bituminous binder being tested.

NOTE 95 % volume ethanol or a 40 % to 50 % mass potassium acetate-water solution has been found to be suitable as a bath liquid.

### 5.1.11 Data acquisition

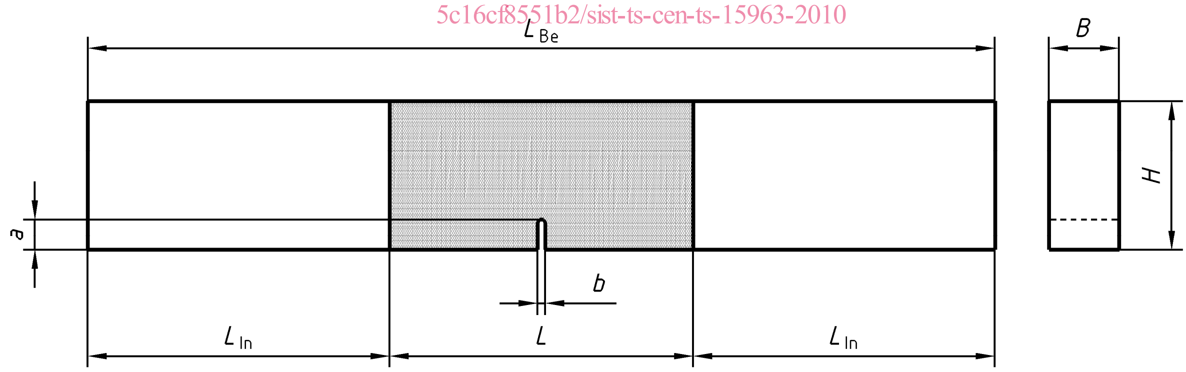
The data acquisition system shall resolve loads to the nearest 100 mN, record specimen deflection to the nearest 0,5 µm, record time to the nearest second and temperature around the sample to the nearest 0,1 °C. The software shall control the measuring system and record time, load, deflection and temperature during the test.

## 5.2 Test specimen



A test specimen as shown on Figure 3 is used. The sample is moulded from the bituminous binder to be assessed. Two aluminium inserts are installed at the ends of the mould. The notch is made by installing two layers of 25 µm thick PTFE film into the pre-notched mould frame.






**Key**

$L_{Be}$ beam length

$L$ specimen length

$L_{In}$ insert length

$H$ specimen height

$B$ specimen thickness

$a$ notch depth

$b$ notch thickness

**Figure 3 — Specimen geometry**

**Table 2 —Test specimen dimensions and tolerances**

| Dimension | Size<br>mm | Tolerance [a]<br>mm |
|---|---|---|
| Beam length, $L_{Be}$ | 120,0 | ± 0,3 |
| Insert length, $L_{In}$ | 40,0 | ± 0,1 |
| Specimen length, $L$ | 40,0 | ± 0,2 |
| Specimen height, $H$ | 25,0 | ± 0,5 |
| Specimen thickness, $B$ | 12,5 | ± 0,3 |
| Notch depth, $a$ | 5,0 | ± 0,1 |
| Notch thickness, $b$ | 2 × 25 µm | / |

[a] Tolerance is related to the mould.

## 6 Preparation of test samples

### 6.1 Preparation of test samples



The laboratory sample shall be taken in accordance with EN 58 and the test samples shall be prepared in accordance with EN 12594.



### 6.2 Preparation of moulds

The moulds for making the samples shall be assembled from aluminium side spacers. On the side spacers and on the bottom a plastic film is glued with an anti-sticking agent to prevent sticking of the bitumen binder to the mould. Two aluminium inserts are installed in the ends of the mould. The surfaces of the aluminium inserts that are in contact with bitumen should be roughened to ensure good adhesion. A series of such assemblies may be clamped together to make more than one specimen at a time. Figure 4 shows the different parts of the mould. Figure 5 shows a picture of such an example assembly and its parts.