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**Bitumen in bitumenska veziva - Določevanje kohezijskih lastnosti bitumenskih veziv - Preskus z nihalom**

Bitumen and bituminous binders - Determination of cohesion of bituminous binders with pendulum test

Bitumen und bitumenhaltige Bindemittel - Bestimmung der Kohäsion von bitumenhaltigen Bindemitteln mit der Pendelprüfung

Bitumes et liants bitumineux - Détermination de la cohésion des liants bitumineux par la méthode du mouton-pendule

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**Ta slovenski standard je istoveten z: EN 13588:2004**

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**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

**SIST EN 13588:2004**

**en**

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EUROPEAN STANDARD  
NORME EUROPÉENNE  
EUROPÄISCHE NORM

**EN 13588**

February 2004

ICS 91.100.50; 93.080.20

English version

## Bitumen and bituminous binders - Determination of cohesion of bituminous binders with pendulum test

Bitumes et liants bitumineux - Détermination de la cohésion des liants bitumineux par la méthode du mouton-pendule

Bitumen und bitumenhaltige Bindemittel - Bestimmung der Kohäsion von bitumenhaltigen Bindemitteln mit der Pendelprüfung

This European Standard was approved by CEN on 10 December 2003.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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## Contents

	page
Foreword.....	3
Introduction .....	4
1 Scope .....	5
2 Normative references .....	5
3 Terms and definitions.....	5
4 Symbols and abbreviations .....	5
5 Principle .....	6
6 Apparatus .....	6
7 Preparation of the sample.....	7
8 Procedure .....	7
8.1 Preparation of cubes and supports .....	7
8.2 Preparation of the binder .....	7
8.3 Preparation of the test assemblies .....	8
8.4 Storage of the assemblies .....	8
8.5 Adjustment of the pendulum .....	8
8.6 Selection of test temperatures .....	9
8.7 Measurement .....	9
8.8 Special precautions .....	9
9 Expression of results .....	10
10 Precision .....	10
10.1 Pure bitumens .....	10
10.2 Polymer modified binders.....	11
11 Test report .....	11
Annex A (normative) Work sheet.....	16
Annex B (normative) Drawing details.....	17
Bibliography .....	18

## Foreword

This document (EN 13588:2004) has been prepared by Technical Committee CEN/TC 336 "Bituminous binders", the secretariat of which is held by AFNOR.

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 August 2004, and conflicting national standards shall be withdrawn at the latest by August 2004.

Annexes A and B are normative.

This document includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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**EN 13588:2004 (E)****Introduction**

The cohesion of the binder is one of the measures of the performance of a surface dressing. It is important to use binders which have sufficient level of cohesion according to the level of traffic to be supported by the surface dressings. A knowledge of cohesion enables the choice of binder type for given traffic and site conditions.

This European Standard describes a method for determining the cohesion of a binder as a main component of a surface dressing, and how to draw the cohesion curve as a function of temperature.

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## 1 Scope

This European Standard specifies a method for measuring the cohesion of bituminous binders at temperatures in the range of -20 °C to 80 °C and for expressing the relationship between cohesion and temperature.

This method is applicable for pure bitumen, modified bitumen and fluxed bitumen; in the case of fluxed bitumen, the test can be performed on the binder containing fluxant or on binder from which the solvent has been removed. For bitumen emulsions, the test is carried out on the residual binder obtained after recovery and the method used to recover the binder should be reported.

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

## 2 Normative references

This European Standard incorporates by dated or undated reference, 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 (including amendments).

EN 58 <sup>1)</sup>, *Bitumen and bituminous binders - Sampling bituminous binders.*

EN 12594, *Bitumen and bituminous binders - Preparation of test samples.*  
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## 3 Terms and definitions

For the purposes of this European Standard, the following term and definition applies.

### cohesion

energy per unit area required to fully detach a cube from the support, with the previously-bonded faces of cube and support remaining fully covered by binder

NOTE Where the cube remains attached to the support after elastic displacement, the energy value measured by the test is always less than the true cohesion value, so the test result can be used to establish that the binder has more than a specified minimum value of cohesion.

## 4 Symbols and abbreviations

For the purposes of this European Standard, the following symbols and abbreviations apply.

$\alpha$   
angle indicated by the pointer after launching the pendulum and impacting a cube placed on and adhered to the support by binder

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<sup>1)</sup> In course of revision.

**EN 13588:2004 (E)** $\alpha'$ 

angle indicated by the pointer after launching the pendulum and impacting a cube with binder, placed on but not adhered to the clean support

 $E$ 

energy required to remove a cube placed on and adhered to the support by binder

 $E'$ 

energy required to remove a cube with binder, placed on but not adhered to the clean support

 $C_m$ 

maximum value of cohesion at the top of the curve

 $T_m$ 

temperature of the test giving the maximum value of cohesion

 $m$ 

mass of pendulum

 $g$ 

acceleration due to gravity

 $r$ 

radius of the centre of gravity of the pendulum

 $s$ 

breaking area

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**5 Principle**

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A 10 mm side steel cube is fixed to a steel support by a film of binder of 1 mm thickness.

The assembly is brought to the test temperature and the cube is dislodged by the impact of a swinging pendulum. The energy absorbed by rupture of the binder is calculated from the angle ( $\alpha$ ) of swing of the pendulum. The determination is performed over a range of at least six temperatures covering the cohesion peak of the binder (see Figure 1).

**6 Apparatus**

**6.1 Cohesion tester**, comprising of the elements specified in 6.1.1 to 6.1.4.

**6.1.1 Base**, set in a horizontal position by means of height adjustment screws and a spirit level, carrying:

- an adjustable quick-release clamping device to hold the test assembly firmly to the base;
- two vertical supports carrying the pendulum, attached to the base;
- a locking system holding the pendulum in a parked position of  $4,0^\circ \pm 1,0^\circ$  angle with the vertical;
- a removable protective cage constructed to allow the pendulum to swing without impediment whilst retaining dislodged cubes.

**6.1.2 A pendulum**, having the form and dimensions specified in Figure 2 capable of rotating freely on a horizontal shaft held in ball bearings in the supports. The mounting for the bearings are adjustable so that the impact edge of the pendulum can be closely adjusted for freedom of swing and height with respect to the test specimen.



1. Pendulum mass : 2 000 g  $\pm$  20 g;
2. Radius at point of impact : 500 mm  $\pm$  1 mm;
3. Distance from pendulum centre of gravity to the shaft : 295 mm  $\pm$  2 mm.

**6.1.3 A pointer** on the pendulum support shaft driven forward by the pendulum but held by an adjustable friction device at the point of maximum swing until manually reset.

A 360° dial graduated in 0,5° interval, with zero in the lower balance position of the pendulum.

**6.1.4 Cubes and cube supports**, steel, to the forms and dimensions shown in Figures 3 and 4, serrated on the faces to be coated with binder.

The mass of any cube is 9,0 g  $\pm$  0,5 g.

NOTE A minimum of four test assemblies, consisting of a cube attached by a film of binder to the cube support, are suggested for each test, and typically three tests are needed at each temperature to show the relationship between cohesion and temperature. It is therefore useful to have 24 cubes and cube supports.

**6.2 Oven**, set at 60 °C  $\pm$  5 °C.

**6.3 Thermostatically controlled enclosure**, incubator air bath or liquid bath capable of maintaining the set temperature within  $\pm$  0,5°C over the range –20 °C to +80 °C.

**6.4 Temperature reading device**, capable of measuring the temperature of the thermostatically controlled enclosure, readable and calibrated to 0,2 °C or less.

**6.5 Other apparatus** including a brush, spatula and knife blade.

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## 7 Preparation of the sample

Ensure that the laboratory sample is homogeneous and the test sample is representative of the laboratory sample from which it is taken in accordance with EN 58. Prepare the sample in accordance with EN 12594.

## 8 Procedure

NOTE Sufficient cubes for not less than eight different test temperatures should be prepared.

### 8.1 Preparation of cubes and supports

Ensure that the cubes and supports are clean by washing in a suitable solvent, using a small brush (6.5) to remove contamination from the serrations.

Dry the cubes and supports in an oven and examine to ensure that they are undamaged.

Pre-heat cubes and supports for each temperature in the oven at 60 °C  $\pm$  5 °C for at least 60 min.

NOTE If the binder is fluxed, the cube and support can be heated for 30 min; if the binder has a softening point above 60 °C accordingly to EN 1427 [1], the cube support should be heated to the softening point with an accuracy of  $\pm$  10 °C.

### 8.2 Preparation of the binder for test

**8.2.1** Ensure that the laboratory sample is homogeneous and the test sample is representative of the laboratory sample from which it is taken in accordance with EN 58.

**EN 13588:2004 (E)**

**8.2.2** Bring the binder to a temperature at which it can be spread on the serrated faces of the pre-heated cube and support (see NOTE). Observe any limitations set by the binder suppliers on heating times and temperatures. If no limitations are available do not heat the binder to a temperature greater than 80 °C above its ring and ball softening point.

NOTE For cutback bitumens, this is usually possible without heating the binder. Heavily modified bitumens require heating to a temperature at which their flow behaviour becomes predominantly viscous.

**8.3 Preparation of the test assemblies**

**8.3.1** Prepare sufficient test assemblies for each temperature.

**8.3.2** Perform the following procedure in less than 2 min:

Take one pre-heated cube and one pre-heated support (6.1.4). Using a small spatula (6.5), apply pre-heated binder to both serrated faces. The total amount of binder applied shall be in excess of that needed to fill the gap between support and cube in the assembly ( $> 0,2$  ml). Immediately place the cube on the support with the serrations facing each other and the ridges on the cube parallel to the edge of the support, which will be parallel to the plane of movement of the pendulum when the assembly is inserted in the clamping device of the tester.

Apply pressure to the cube and support so that excess binder is squeezed out and the ridges of the cube are in contact with the support.

NOTE Some binders show elastic behaviour which can lead to stress being retained in the binder film and poor repeatability between tests. In extreme cases the cube may lift from the support before testing commences. To avoid this problem the cube, support and sample should be pre-heated to a higher temperature.

**8.3.3** Repeat 8.3.2 for each test assembly.

**8.3.4** Remove the excess binder from the cube faces of the test assemblies by scraping with a knife blade (6.5), which may be heated. If necessary, clean the cube face which will be struck by the pendulum using absorbent paper with a little solvent. Ensure that the solvent does not contaminate the exposed edge of the film of binder.

**8.3.5** Place the test assemblies in an oven set at a temperature equal to the softening point of the binder with an accuracy of  $\pm 5$  °C for at least 60 min.

**8.4 Storage of the assemblies**

Place the set of test assemblies in a thermostatically controlled enclosure maintained at the required test temperature for 90 min to 4 h if a liquid bath is used, or 3 h to 15 h if an air bath is used.

**8.5 Adjustment of the pendulum**

Place the cohesion tester on a rigid, stable support and ensure that it is level. Check that the impact edge of the pendulum is undamaged and straight. Set the pendulum hanging freely in the down position and ensure that the scale reading is  $0^\circ \pm 0,5^\circ$  by adjusting the scale dial, if necessary. Adjust the position of the clamping device so that a test assembly is held in a position such that the impact edge of the pendulum is parallel to the bottom edge of the cube and just in contact with the cube over its full length, at a height of  $2,0 \text{ mm} \pm 0,2 \text{ mm}$  above the top of the serrations of the cube support (see annex B).

Set the pendulum in the “up” position.

Set the pointer in contact with the pendulum in this “up” position.

Release the pendulum repeatedly with no test assembly in position until the swing-through angle of the pendulum reach at least  $155,0^\circ \pm 0,5^\circ$  constantly for six successive swings.

NOTE 1 In the “up” position, the pendulum and pointer are at an angle of  $4,0^\circ \pm 1,0^\circ$  with the vertical, and no impulse is required for release.

NOTE 2 The pointer retaining system is sensitive to temperature variation and the room ambient temperature should be in the range 18 °C to 28 °C during preparation of the apparatus and for subsequent testing. In such case the energy dissipated in friction during a pendulum swing without a test specimen should be considered negligible compared to the energy absorbed by breaking a binder during a test.

## 8.6 Selection of test temperatures

Select three temperatures at 10 °C intervals according to the observed room temperature consistency of the binder, e.g. 10 °C, 20 °C, 30 °C for fluxed bitumens, 30 °C, 40 °C, 50 °C for stabilised pure or modified bitumens.

Then select additional test temperatures so that at least:

- one result is less than 0,4 J/cm<sup>2</sup> at both the low and high temperature end of the curve;
- three results are within 5 °C of the temperature of maximum cohesion.

NOTE If a binder has been already tested, larger or smaller intervals than 10 °C can be used and another range of temperatures selected according to the intention of the test.

## 8.7 Measurement

Set the pendulum in the "up" position, and reset the pointer in contact with the pendulum.

Open the door of the protective cage.

Transfer a test assembly from the temperature-controlled environment to the clamping device of the tester taking care to ensure that the assembly is moved without disturbance of the cube relative to the support. Close the door of the protective cage and release the pendulum. Ensure that the time taken to perform the above procedure since the transfer is less than 20 s and that all tests at one temperature are performed within a 10 min period.

Record the swing-through angle  $\alpha$  indicated by the pointer to the nearest 0,5°.

Remove the detached cube support from the protective cage and examine the faces in contact with binder for evidence of adhesion failure. If an area of bare metal greater than 5 mm<sup>2</sup> is visible, record this.

Examine the impact edge of the pendulum. If any binder is adhering, remove it using absorbent paper with a small quantity of solvent.

Reset the pendulum in the "up" position and reset the pointer in contact with the pendulum.

Replace the cube support with another, clean, support and place the cube just tested on this support with its clean face downwards.

Release the pendulum and record the swing-through angle  $\alpha'_1$  indicated by the pointer to the nearest half-degree.

Repeat the measurements for the other test pieces and note the angles  $\alpha$ ,  $\alpha'_2$ ,.....  $\alpha_6$ ,  $\alpha'_6$ .

## 8.8 Special precautions

The cohesion value is the difference between the two measurements with and without binder. Ensure that these measurements are consecutive and are as close together as possible, i.e. not more than 2 min apart, in order to achieve optimum test accuracy.

At temperatures close to maximum cohesion, the break of the binder on impact may occasionally result in binder remaining on the support. If the pendulum contacts this residual binder the swing-through angle will be reduced. It is important to detect this phenomenon to avoid the risk of errors. If this occurs a repeat test should be carried out at an alternative temperature.