British Standard

BRITISH STANDARD

BS EN
1871:2000

Road marking materials — Physical properties

The European Standard EN 1871:2000 has the status of a British Standard

ICS 93.080.20

National foreword

This British Standard is the official English language version of EN 1871:2000.

The UK participation in its preparation was entrusted by Technical Committee B/509, Road equipment, to Subcommittee B/509/2, Horizontal road markings and road studs, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

BS 3262-1:1989 is declared obsolescent on the publiaction of this standard.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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Summary of pages

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Road marking materials - Physical properties

Produits de marquage routier - Propriétés physiques

Straßenmarkierungsmaterialien - Physikalische Eigenschaften

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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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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 226, Road equipment, 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of an identical text or by endorsement, at the latest by July 2000, and conflicting national standards shall be withdrawn at the latest by July 2000.

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

The annexes A, B, C, D, E, F, G, H, J and K of this European Standard are normative.

Introduction

This European Standard gives the physical properties of road marking materials used in horizontal signalization. It includes annexes for test methods. Identification requirements are covered in prEN 12802:1999.

1 Scope

This European Standard specifies the laboratory requirements and test methods for retroreflective and other road marking materials, both permanent and temporary.

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 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 1436:1997	Road marking materials – Road marking performance for road users
prEN 12802:1999	Road marking materials – Laboratory methods for identification
ISO 787-11:1981	General methods of test for pigments and extenders – Part 11: Determination of tamped volume and apparent density after tamping
ISO 1514:1993	Paints and varnishes – Standard panels for testing
ISO 2814	Paints and varnishes – Comparison of contrast ratio (hiding power) of paints of the same type and colour
ISO 4892	Plastics – Methods of exposure to laboratory light sources Part 1: General guidance Part 2: Xenon-arc sources Part 3: Fluorescent UV lamps
ISO 7724-2	Paints and varnishes – Colorimetry – Part 2: Colour measurement

3 Definitions

For the purposes of this standard the following definitions apply.

3.1 paint: a liquid product containing solids suspended in an organic solvent or in water. It can be supplied in single or multi-component systems. When applied by brush, roller, spray or any other appropriate method it produces a cohesive film by the process of solvent evaporation and/or by a chemical process.

3.2 thermoplastics: a solvent-free marking substance supplied in block, granular or powder forms. It is heated to a molten state and then applied with an appropriate hand or mechanical applicator. It forms a cohesive film by cooling.

3.3 cold plastics: a marking substance which is supplied in single or multi-component forms. Depending on the type of system the components are mixed together in various ratios and applied with an appropriate applicator. It forms a cohesive film only by a chemical process.

4 Requirements

4.1 Paint

4.1.1 Chromaticity co-ordinates and luminance factor.

The daytime visibility of road marking paint shall be defined by the luminance factor β. The colour shall be defined by *x,y* chromaticity co-ordinates of the CIE standard system in accordance with EN 1436:1997.

Panels shall be prepared and measurements carried out according to annex A. For the luminance factor the classes in Table 1 shall apply. The chromaticity co-ordinates are confined by specified regions in the *x,y* colour diagram by means of the corner points shown in Table 2.

Table 1: Classes of luminance factor

Colour	Class	Luminance factor β
White	LF5 LF6 LF7	$\geq 0{,}75$ $\geq 0{,}80$ $\geq 0{,}85$
Yellow	LF1 LF2	$\geq 0{,}40$ $\geq 0{,}50$

Table 2: Chromaticity co-ordinates of white and yellow road marking products

Corner point N°		1	2	3	4
White	*x*	0,355	0,305	0,285	0,335
	y	0,355	0,305	0,325	0,375
Yellow	*x*	0,494	0,545	0,465	0,427
	y	0,427	0,455	0,535	0,483

4.1.2 Hiding power

The contrast ratio (hiding power) for white and yellow paints shall be not less than 95 % for white and 90 % for yellow when tested in accordance with ISO 2814 when applied with a doctor blade of 300 μm.

4.1.3 Storage stability

The paint shall be free from skin and settlement that cannot be re-incorporated by stirring. The paint shall have a rating equal to or above 4 when tested in accordance with annex B.

The components of multicomponent paint shall each be tested separately in different containers.

4.1.4. UV ageing

4.1.4.1 General

The paint shall be applied as in A.3 to panels as described in A.2 and tested in accordance with ISO 4892-3 by either of the two test procedures described in 4.1.4.2 and 4.1.4.3. The difference in luminance factor $\Delta\beta$ shall be as in Table 3 (where $\Delta\beta$ = original luminance factor – luminance factor after test). The chromaticity co-ordinates shall be as given in Table 2.

4.1.4.2 UVA ageing

The specimens shall be tested in accordance with ISO 4892-3 for 480 h under lamp type I (UVA - 340) in cycles of 8 h of radiation at 60 °C ± 2 °C and 4 h of condensation at 50 °C ± 2 °C.

4.1.4.3 UVB ageing

The specimens shall be tested in accordance with ISO 4892-3 for 168 h under lamp type II (UVB - 313) in cycles of 8 h of radiation at 60 °C ± 2 °C and 4 h of condensation at 50 °C ± 2 °C.

Table 3: Classes of difference in luminance factor after UV ageing

Colour	Class	$\Delta\beta$
White and Yellow	UV0	No requirement
	UV1	$\leq$ 0,05

4.1.5 Bleed resistance

When tested in accordance with annex C the difference in luminance factor $\Delta\beta$ shall be as in Table 4. The chromaticity co-ordinates shall be as in Table 2.

NOTE: This test is only applicable for paint which is to be applied directly to asphaltic surfaces.

Table 4: Classes of difference in luminance factor after bleed resistance test

Colour	Class	$\Delta\beta$
White and Yellow	BR0 BR1 BR2	No requirement ≤ 0,03 ≤ 0,05

4.1.6 Alkali resistance

When tested in accordance with annex D the paint film shall show no deterioration of the surface.

NOTE: This test is only applicable for paint which is to be applied directly to hydraulic concrete surfaces.

4.2 Thermoplastics

4.2.1 Tests before heat stability test

4.2.1.1 Chromaticity co-ordinates and luminance factor

When tested in accordance with annex E the luminance factor shall be given as in Table 5 and the chromaticity co-ordinates as in Table 2.

Table 5: Classes of luminance factor for thermoplastics and cold plastics

Colour	Class	Luminance factor β
White	LF3 LF4 LF6	≥ 0,65 ≥ 0,70 ≥ 0,80
Yellow	LF1 LF2	≥ 0,40 ≥ 0,50

4.2.1.2 Softening point

When tested in accordance with annex F the softening point of the material shall comply with the classes as given in Table 6.

Table 6: Classes of softening point for thermoplastics

Class	Softening point in °C
SP0	No requirement
SP1	≥ 65
SP2	≥ 80
SP3	≥ 95
SP4	≥ 110

4.2.1.3 Alkali resistance

When tested in accordance with annex D the specimen shall show no deterioration of the surface.

NOTE: This test is only applicable for thermoplastics which are to be applied directly to hydraulic concrete surfaces.

4.2.1.4 Cold impact

When tested in accordance with annex H the number of specimens passing the test shall comply with the classes as given in Table 7.

Table 7: Classes for cold impact

Class	Temperature of test in °C	Ball	Number of specimens passing
CI 0	No requirement	-	No requirement
CI 1	0	a	6
CI 2	-10 ± 3	a	6
CI 3	-10 ± 3	b	6

4.2.1.5 UV ageing

The material shall be applied at the manufacturer's stated thickness to panels as described in A.2 and tested in accordance with ISO 4892-3 and as described in either 4.1.4.2 or 4.1.4.3. The difference in luminance factor $\Delta\beta$ shall comply with the classes as in Table 3. The chromaticity co-ordinates shall be as given in Table 2.

4.2.2 Heat stability

The heat stability of the product shall be tested in accordance with annex G and the tests specified in 4.2.3 shall be subsequently carried out.

NOTE: This test is not applicable for heat applied preformed thermoplastics.

4.2.3 Tests after heat stability test

4.2.3.1 Chromaticity co-ordinates and luminance factor

When tested in accordance with annex E the difference in luminance factor $\Delta\beta$ shall be no more than 0,10 for both white and yellow. The chromaticity co-ordinates shall be as given in Table 2.

4.2.3.2 Softening point

When tested in accordance with annex F the difference in softening point ΔSP shall not be more than ± 10 °C.

4.2.3.3 Indentation

When tested in accordance with annex J the mean value for the indentation time shall comply with the classes as given in Table 8.

Table 8: Classes for indentation

Class	Indentation time
IN0	No requirement
IN1	5 s to 45 s
IN2	46 s to 5 min
IN3	2 min to 5 min
IN4	6 min to 20 min
IN5	> 20 min

4.2.2.4 Tröger wear

When tested in accordance with annex K the mean value for volume loss shall comply with the classes as given in Table 9.

Table 9: Classes for Tröger wear

Class	Volume loss in cm^3 3 mm thick/16 periods	Volume loss in cm^3 1,5 mm thick/5 periods
TW0	No requirement	No requirement
TW1	< 2,5	-
TW2	2,5 to 5	-
TW3	-	< 1,5
TW4	-	1,5 to 3

4.2.3.5 UV ageing (Xenon arc)

The material shall be applied at the manufacturer's stated thickness to panels as described in A.2 or Marshall specimens as described in K.3.2 and tested in accordance with ISO 4892-2. The difference in luminance factor $\Delta\beta$ shall comply with the classes as given in Table 3. The chromaticity co-ordinates shall be as given in Table 2.

The UV test is performed for 1 000 h in either sprayed or flooded cycles of 18 min duration and with dry intervals of 102 min. Relative humidity shall be 50 %, black standard temperature 45 °C, and irradiation (between 290 nm and 800 nm) 550 W/m^2. The Marshall test specimens shall be placed horizontally in the equipment.

NOTE: Equipment that can be used for the UV test on Marshall test specimens are Xeno test 250, Sun test or Sun test CPS+.

4.2.3.6 Tröger wear (after UV ageing)

When tested in accordance with ISO 4892-2 and annex K the mean values for the difference in volume loss shall comply with the classes as given in Table 10.

Table 10: Classes for Tröger wear after UV ageing

Class	Difference in volume loss in cm^3
TWU0	No requirement
TWU1	0 to < 0,5
TWU2	0,5 to 2,5

4.3 Cold plastics

4.3.1 General

For each of the tests at least 500 g of material shall be prepared in the specified manner.

4.3.2 Chromaticity co-ordinates and luminance factor

When applied at the manufacturer's stated thickness and tested in accordance with annex A the luminance factor shall be as given in Table 5 and the chromaticity co-ordinates as in Table 2.

4.3.3 Storage stability

The material shall be free from skin and settlement that cannot be incorporated by stirring. The cold plastics shall have a rating equal to or above 3 when tested in accordance with annex B. The components of cold plastics shall each be tested separately in different containers.

NOTE: See B.3.2 for components containing peroxides.

4.3.4 UV ageing

The material shall be applied at the manufacturer’s stated thickness to panels as described in A.2 and tested in accordance with ISO 4892-3 as described in either 4.1.4.2 or 4.1.4.3. The difference in luminance factor $\Delta\beta$ shall comply with the classes as given in Table 3. The chromaticity co-ordinates shall be as given in Table 2.

4.3.5 Alkali resistance

When tested in accordance with annex D the specimen shall show no deterioration of the surface.

NOTE: This test is only applicable for cold plastics which are to be applied directly to hydraulic concrete surfaces.

4.3.6 Tröger wear

When tested in accordance with annex K the mean value for volume loss shall comply with the classes as given in Table 9.

4.3.7 Tröger wear after UV ageing

When tested in accordance with ISO 4892-2 and annex K the mean value for the difference in volume loss shall comply with the classes as given in Table 10.

Annex A (normative)

Paint and cold plastics – Test method for determining the chromaticity co-ordinates and luminance factor

A.1 Principle and apparatus

The principle of measurement and the choice of apparatus are given in annex C of EN 1436:1997.

Calibration shall be based on methods acknowledged by an accredited laboratory. Reference tiles or other calibration references shall have a calibration traceable to an accredited laboratory.

A.2 Materials

Test panels shall be made of aluminium, of minimum size 150 mm x 75 mm x 0,60 mm, prepared for test by solvent cleaning.

A.3 Procedure

Prepare the aluminium panel and apply the paint or cold plastic to the panel to give a wet film thickness of 400 μm ± 35 μm using shims and a doctor blade. In the case of paint containing premix glass beads a coating equivalent to 1 000 g/m^2 may be applied. Allow the panel to dry for seven days in a horizontal position at 23 °C ± 5 °C and 50 % ± 5 % relative humidity, out of sunlight and with protection from dust.

Measure in accordance with annex C of EN 1436:1997.

Annex B (normative)

Paint and cold plastics – Test method for determining the storage stability

B.1 Principle

The test method covers the determination of the degree of pigment suspension and ease of remixing a shelf-aged sample of paint to a homogeneous condition suitable for immediate use.

B.2 Apparatus

a) Three 250 ml wide-neck bottles (test vessels) of clear glass, 55 mm in diameter, 110 mm in height, with an opening 45 mm in diameter with an ISO thread and a screw-type plastic (PE) inset top;

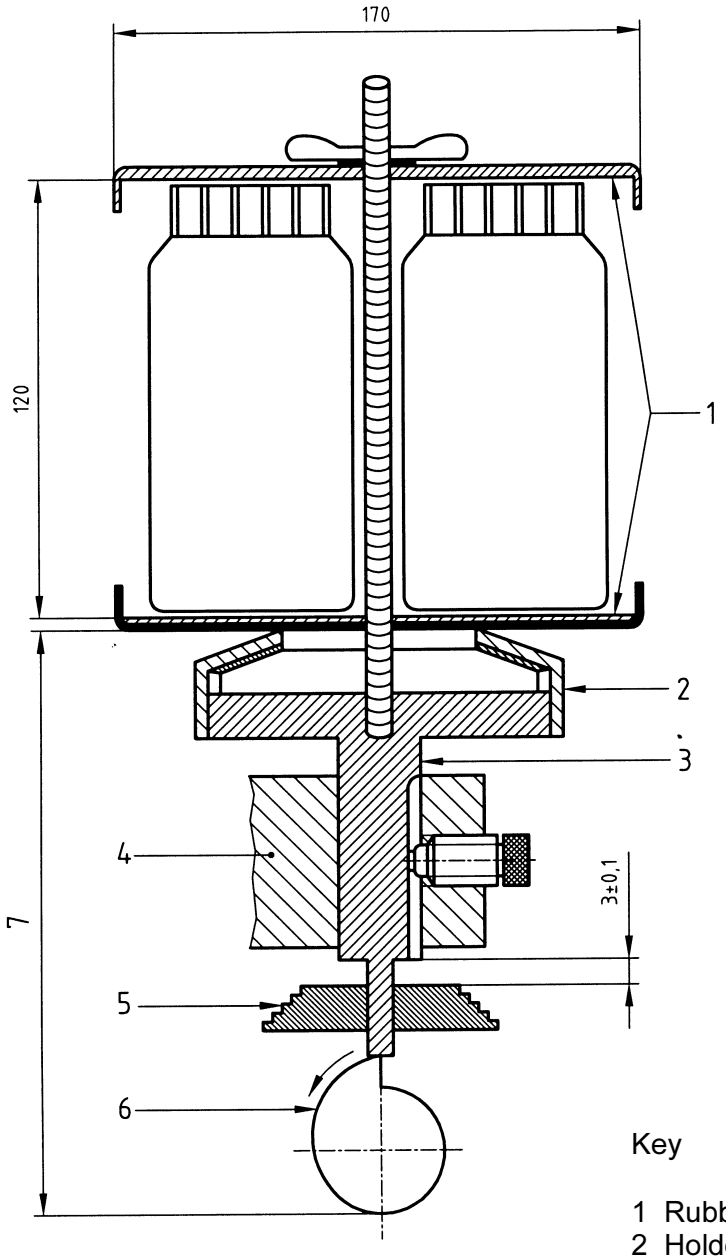
b) steel spatula weighing 45 g ± 1 g, square, 123 mm ± 1 mm in length and with a blade 20,5 mm ± 0,5 mm in width. The spatula shall be made by cutting the top from an ordinary 127 mm flexible steel laboratory spatula to obtain the specified length;

c) warming cabinet, with forced ventilation capable of reaching a temperature of 45 °C ± 2,5 °C;

d) tamping apparatus in accordance with ISO 787-11:1981 (see Figure B.1);

e) holder for the test vessel (see Figure B.1).

Dimensions in millimetres



Key

1 Rubber sleeve 1 mm
2 Holder for measuring cylinder
3 Shaft
4 Sleeve
5 Anvil
6 Cam
7 ISO 787-11:1981

Figure B.1: Tamping volumeter

B.3 Procedure

B.3.1 Paint

Place a sample of the paint in each of the three 250 ml wide-neck bottles, taking care to ensure that the level of paint in each test vessel is identical and reaches the lower edge of the thread (approximately 20 mm below the screw top but to a maximum of 80 % of the volume).

The edges and thread of the test vessels shall be thoroughly cleaned using cellulose and solvent. The test vessels are then hermetically closed and labelled 1 to 3. The samples are then weighed to the nearest 0,1 g and stored in the warming cabinet for a total of 30 days at 45 °C. After each seven day period the samples are subjected to 25 000 strokes of the automatic tamping equipment. By observing the samples through the glass it can be seen whether the phases separate.

After each series of 25 000 strokes the samples are returned into the warming cabinet. All three samples are reweighed immediately after storage under accelerated conditions (action of heat and tamping) in order to determine any loss of mass. Loss of weight shall not exceed 2 %. Any samples with a loss of mass exceeding 2 % are deemed to have failed the test.

B.3.2 Cold plastics

Cold plastics are tested in the same way as multicomponent paints. The components of cold plastic shall be tested for the presence of peroxides prior to testing.

The components containing peroxides shall not be stored in the warming cabinet but at room temperature and shall not be subjected to the tamping test.

B.4 Determination of the degree of suspension and ease of remixing

After weighing, open the three test vessels carefully without shaking or agitation and examine the samples. Do not remove any surface layer that may have formed on the samples (skin formation). Use a spatula to examine the extent to which portions of the paint have separated to form a layer at the bottom of the test vessel during storage and tamping. Hold one end of the spatula so that it is perpendicular to the central area of the paint and its bottom edge is level with the top of the test vessel. Drop the spatula from this height, then move the spatula manually over the bottom of the test vessel in a lateral direction. Assess the resistance of the cake of settled pigment to this movement and the ease of remixing for all three samples in accordance with B.5, after which determine and record the average rating for the three samples.

B.5 Rating

Rate the sample for degree of settling on a scale of 10 to 0 in accordance with Table B.1. Give intermediate conditions the appropriate odd number.

Table B.1 : Rating scale for storage stability

Rating	Description of product condition
10	Perfect suspension. No change from the original condition of the product.
8	Settling has definitely taken place. A slight deposit is raised when the spatula is dropped into the product. No significant resistance to sideways movement of the spatula.
6	Definite cake of settled pigment. Spatula drops through cake under its own weight. Definite resistance to sideways motion of the spatula. Coherent portions of cake may be removed on spatula. Product can be remixed readily to a homogeneous state.
4	Spatula does not fall through cake to bottom of test vessel under its own weight. Difficult to move spatula through cake sideways and slight edgewise resistance. Product can be remixed readily to a homogeneous state.
3	Definite resistance to edgewise movement of the spatula after it has been pushed through the settled layer by exerting slight pressure on it. Product can be remixed to a homogeneous state by stirring manually with a small amount of effort.
2	When spatula has been forced through the settled layer it is very difficult to move spatula sideways. Definite edgewise resistance to movement of spatula. Paint can be remixed to a homogeneous state.
0	Very firm cake that cannot be incorporated with the liquid to form a smooth homogeneous product by stirring manually.

NOTE: A non-accelerated test may be carried out in the following manner.
Place a sample of paint or cold plastic to within 13 mm of the top of a 500 ml friction top paint tin (86,0 mm ± 1,6 mm diameter and 96,4 mm ± 1,6 mm in height) and close tightly. Store undisturbed for shelf ageing at between 18 °C and 23 °C for 6 months or said period as agreed by the purchaser or seller. Test for settlement in accordance with B.4 and record the result in accordance with B.5.

Annex C (normative)

Paint – Test method for determining the bleed resistance

C.1 Principle

The paint is applied to a bitumen surface and the film is examined for discoloration after conditioning for 72 h.

C.2 Apparatus and materials

a) Light source and colorimeter as described in annex C of EN 1436:1997;

b) warming cabinet with forced ventilation capable of reaching a temperature of 45 °C ± 2,5 °C;

c) hardboard panels in accordance with ISO 1514:1993, clause 3 and at least 100 mm x 200 mm x 10 mm in size with density > 0,80 g/cm^3;

d) doctor blade with which to apply the paint, with a minimum slit size of 300 μm and 60 mm or 80 mm wide;

e) Type B 70/100 pen bitumen or similar. The quantity should be sufficient to coat the required number of carrier panels;

f) toluol (solvent).

C.3 Preparation of carrier panel

Several coats of a 50 % bitumen solution in toluol are applied with a brush to the smooth face of the carrier panel in an efficient fume cupboard such that 1 g of bitumen shall remain on the plate after drying. The carrier panel is first stored in a warming cabinet for 72 h at 45 °C, then for 12 h at room temperature in order to age the bitumen remaining on the carrier panel.

C.4 Procedure

Place a strip of transparent tape of width not less than 50 mm on the bitumen surface, approximately 75 mm from the edge of the panel and parallel to the 200 mm side.

Thoroughly stir the paint under test and apply over the whole length of the carrier panel within approximately 4 s using a doctor blade with a slit size of 300 μm.

Mix the components of a multicomponent paint immediately prior to application of the film in the ratio specified by the manufacturer. Ensure that the components are mixed thoroughly.

After the test panel (consisting of the carrier panel plus road marking paint) has been dried for 72 h at approximately 20 °C and then for 24 h at 45 °C, the luminance factor of the paint both on the coated test surface to which adhesive tape is applied (β) and on the test surface coated with bitumen (β') is determined photometrically in accordance with annex C of EN 1436:1997. Record both values. Calculate the difference between the luminance factor of the paint on the transparent tape β and that of the paint on the bitumen coating β' ($\Delta\beta = \beta - \beta'$).

Annex D (normative)

Paint, cold plastics and thermoplastics - Test method for determining the alkali resistance of the materials

D.1 General

The purpose of this test method is to aid the selection of a road marking material which is suitable for direct application onto alkaline reactive substrates (hydraulic concrete pavements).

D.2 Principle

A specimen fraction of paint or cold plastics is applied to three carrier panels using a doctor blade. A specimen fraction of a thermoplastic material is heated to a mouldable state, pressed into a sheet and then applied to three carrier panels. The test panels are conditioned and clamped into a frame where the coatings are subjected to the action of a 10 % solution of sodium hydroxide for a period of 48 h. After watering and brushing, the surface characteristics of the test zones are assessed.

D.3 Apparatus and reagents

D.3.1 General

a) Frame with clamping device;

b) perforated plates, two plates 100 mm x 200 mm x 10 mm of acrylic glass with perforations of approximately 40 mm diameter situated on the longitudinal centre line at distances of 25 mm and 125 mm respectively from one end of the plate;

c) cover plates, two plates 100 mm x 200 mm x 10 mm of acrylic glass;

d) spatula;

e) nail brush;

f) oven, capable of forced circulation to a temperature of 45 °C ± 3 °C, aeration;

g) carrier panels, three panels 100 mm x 200 mm x 10 mm of acrylic glass, transparent, roughened, graining of 150 flint coated paper;

h) solution of 10 % sodium hydroxide, in water.

D.3.2 Paint and cold plastics

a) Doctor blade with which to apply the paint or cold plastics, with a minimum slit size of 400 μm to 1 000 μm and 60 mm or 80 mm wide, or screed box with adjustable slit for cold plastics.

b) beaker, 400 ml capacity.

D.3.3 Thermoplastics

a) Vessel with lid;

b) paint scraper;

c) pen knife;

d) roll mill, with two rolls (each at least 300 mm long);

e) heat resistant plastic foil, 300 mm wide, heat resistant to 200 °C;

f) heating cabinet, capable of being set to any temperature up to 200 °C.

D.4 Number of tests

A specimen fraction of each material is applied to three carrier panels. Two of these panels are subjected to the sodium hydroxide solution and subsequently tested. The third one serves as a reference.

D.5 Preparation of test panels.

D.5.1 Paint

Apply a specimen fraction of the paint to be tested to three roughened acrylic glass carrier panels, 100 mm x 200 mm x 10 mm, using a doctor blade. The slit size of the doctor blade corresponds to the wet film thickness prescribed by the paint manufacturer (at least 400 μm).

Mix the components of multicomponent paints (at the mixing ratio prescribed by the manufacturer) directly before application. Ensure that the components are mixed thoroughly.

If the manufacturer prescribes that the paint be applied in several layers, select the slit width of the doctor blade which corresponds to the largest of the wet film thicknesses stated.

> NOTE: The phenomena related to the bond between two paint layers are not covered by this test.

Screen a paint containing oversize before application. Take care to use a screen with an opening slit as close as possible to the wet film thickness to be applied.

Condition the test panels (carrier panels with paint) by storing for 12 h at room temperature and then in an oven, in a horizontal position, for 150 h at a temperature of 45 °C ± 3 °C. Cool the test panels to room temperature.

D.5.2 Thermoplastics

Store a specimen fraction of thermoplastics of approximately 1 kg, placed in a vessel covered with a lid, in an oven to be heated to a mouldable state. Specific temperatures cannot be stated since the application temperatures for thermoplastics are usually in the range 160 °C to 200 °C. In general, the application temperature stated by the manufacturer should be adequate. If a manufacturer gives a range of temperatures, the heating cabinet should be adjusted to the average value of the temperatures stated.

Having reached the mouldable state, stir the heated specimen fraction with a paint scraper for homogenization.

Adjust the gap between the two rolls of the mill so that a sample of the layer thickness prescribed by the manufacturer can be produced by pressing between two sheets of heat resistant plastic foil.

A strip of heat resistant plastic foil of length of approximately 3 m is folded in half. The fold is inserted between the two rolls, wrapping the two ends of the folded strip around them.

After homogenization, and while the sample is still in a mouldable state, gradually place it between the two strips of heat resistant plastic foil while a second operator slowly and uniformly operating the crank handle of the roll mill. The rotative motion of the rolls pulls the two halves of the foil strip between the rolls pressing them together and at the same time producing a sheet sample of defined thickness. After cooling to room temperature, cut panels from the sheet using a pen knife and one of the carrier panels as a template. Using the carrier panels, prepare three test panels. Condition the three test panels (carrier panels with thermoplastics) by storing, in a horizontal position, in an oven for 14 days at a temperature of 45 °C ± 3 °C, then cool the test panels to room temperature.

D.5.3 Cold plastics

NOTE: Safety glasses should be worn when handling peroxides.

Mix cold plastics components immediately before application. Using the mixing ratio prescribed by the manufacturer, weigh a total of 250 g of mixed product prepared from all components to an accuracy of 1 % into a beaker. Weigh the basic material first, followed by the other components. Stir the components intensively using a spatula for 1 min, or according to the manufacturer's instructions. Apply the cold plastics to be tested to three roughened carrier panels using a doctor blade or a screed box. The slit size, in this case, shall be the equivalent of the wet film thickness of the material prescribed by the manufacturer of the cold plastics (at least 400 μm).

Eliminate any impurities or oversize in any of the components by screening the material before mixing using a screen with an opening width as close as possible to the wet film thickness to be applied.

Condition the test panels (carrier panels with cold plastics) by storing for 12 h at room temperature and afterwards in an oven, in a horizontal position, for 14 days at a temperature of 45 °C ± 3 °C. Cool the test panels to room temperature.

D.6 Testing

Use one of the panels as a reference. Place the two remaining panels, with the material face up, in a suitable frame and cover each with a 10 mm thick perforated plate. Glue sponge rubber onto the bottom edges of the perforated plates. Using a pressing device press the perforated plates onto the test panels. The sponge rubber acts as sealant between the test panel and the perforated plate. Fill the cavities which are produced above the test panels to the rim with sodium hydroxide solution of 10 % concentration. Cover the perforated plates using the cover panels.

Subject the material to the effect of the sodium hydroxide solution for a period of 48 h at 45 °C, then stir up the sodium hydroxide solution using a glass spatula through the perforations of the perforated plates. Check the sodium hydroxide solution for any distinct and intense colouring as a result of the chemical reaction (its effect on the binder) and for clouds as a result of pigment disturbance.

After examination decant the sodium hydroxide solution. Remove the test panels from the frame, place under running water, and brush with a hard nail brush until all loose particles are removed from the test zone (till the rinsing water is clear).
Inspect the test zones of the material, where they have been subjected to the effect of sodium hydroxide solution, for any signs of destruction by the solution. If any intense discoloration is observed, dry the test panels in an oven at 45 °C before evaluation.

D.7 Evaluation

D.7.1 Condition of the sodium hydroxide test solution

Any distinct and intense coloration of the sodium hydroxide test solution as a result of its effect on the binder shall be recorded as well as pigment disturbance as a result of the stirring.

D.7.2 Surface condition of the test zones

The surface of the coloured films in the zones subjected to the test solution shall be described with respect to the following: signs of partial or complete film destruction, surface roughening or discoloration.

The surface condition of the test zones of both thermoplastics and cold plastics shall be described with respect to the following: loss of gloss, change in colour, surface roughening and abrasion. Possible retroreflective properties are checked by inclining the test panels against the light to find out whether glass beads have been exposed or not.

D.8 Assessing the materials

D.8.1 Paint

An appropriate criterion is the chemical resistance to sodium hydroxide solution of the paint surface. The adhesion of the paint to the concrete surface is a function of its chemical resistance. For thin films the binder can be completely hydrolized by the test solution. In this case film adhesion or cohesion losses might be used as criterion for alkali resistance.

The paint is alkali resistant if it cannot be brushed off with a hard nail brush in the zones subjected to the effect of the test solution.

D.8.2 Thermoplastics and cold plastics

Thermoplastics and cold plastics are alkali resistant if, generally:

a) the sodium hydroxide test solution, after a reaction time of 48 h and stirring, shows no sign of distinct and intense colouring nor any clouding as a result of pigment disturbance;

b) the test zones of the material neither show a sign of surface roughening nor one indicating that the glass beads have been exposed.

D.9 Precision and repetition

The two panels shall give the same result otherwise the test shall be repeated.

Annex E (normative)

Thermoplastics – Test method for determining the chromaticity co-ordinates and luminance factor

E.1 Principle

The principle of measurement is given in annex C of EN 1436:1997. A solid block of thermoplastic material is measured. This test method specifies a test specimen of appropriate dimension and thickness to give a smooth surface and maximum reflection. Other specimens can be used if it is verified that they have the same specific properties.

E.2 Apparatus

a) Light source and measuring device as in annex C of EN 1436:1997;

b) silicone rubber mould consisting of a flat sheet of silicone rubber, approximately 10 mm thick, to be used as a base plate and a top sheet of similar size and thickness with a 100 mm circle cut in it.

E.3 Procedure

E.3.1 Melt sufficient material to fill a prepared rubber mould and cast a slab of approximately 100 mm in diameter and 10 mm thick.

NOTE 1: Materials should not be heated above the manufacturer's stated safe heating temperature.

NOTE 2: For routine purposes specimens may be cast on a smooth metal sheet coated with a permanent release coating of PTFE (polytetrafluorethylene).

In case of dispute, use the rubber mould.

NOTE 3: If, after having been tested, the specimen is to be kept for further measurements, it should be returned to its mould and kept at a low temperature, preferably in a refrigerator, in order to avoid distortion.

NOTE 4: Provided the cast face (undersurface) of the specimen is used for the measurement, the presence of solid glass beads in the material is unlikely to affect its luminance.
If necessary, in order to obtain a smooth undersurface, the top of the mould may be loaded with a mass of 5 kg whilst the specimen is warm.

E.3.2 Allow the specimen to cool to room temperature, remove it from the mould and immediately measure the chromaticity co-ordinates *x* and *y* on three different areas of the undersurface of the specimen.

Annex F (normative)

Thermoplastics – Test method for determining the softening point

F.1 Principle

The principle of this method is to determine the softening point of thermoplastic road materials in accordance with Wilhelmi.

The softening point is the temperature, under the testing conditions of this method, at which a given layer of thermoplastic material experiences a given deformation under the action of a steel ball of 13,9 g mass.

F.2 Apparatus

a) Ring, in accordance with Wilhelmi (see Figure F.1), consisting of a bottom ring half and a top ring half with bayonet catch, retaining rod and prominently protruding nipples;

b) beaker, appropriate form for the equipment;

c) steel ball of mass 13,9 g ± 0,1 g (approximate diameter 15 mm);

d) thermometer +30 °C to +200 °C graduated in 0,5 °C divisions;

e) base plate of metal or glass;

f) mould parting agent, e.g. mixture of glycerine and dextrine in 1:1 ratio;

g) knife;

h) tongs or tweezers, for holding the ball;

i) test liquids, freshly boiled distilled water, glycerine;

j) device for heating the beaker, enabling the temperature of the test liquid to be raised uniformly from 5 °C to 180 °C at a rate of 5 °C per 60 s ± 5 s and with stirring if necessary to maintain a constant heating rate.

F.3 Samples

The sample mass shall amount to approximately 50 g. Two test specimens shall be tested.

F.4 Preparation of the ring

Heat the bottom half of the ring and base plate, thinly coated with the mould parting agent, together with the sample, to the manufacturer’s suggested softening point +70 °C.

Fill the bottom half of the ring with the hot material. Place the top half of the ring onto the bottom half so that the superfluous portion of the material is pressed out of the whole of the top half and leave standing for 30 min at room temperature (18 °C to 28 °C). The salient portion of the test specimen is trimmed off with the warmed knife so that the surface of the test specimen is smooth and flat.

Insert the bottom half of the ring into the top half and fasten with the bayonet catch. The test specimen is now firmly clamped between the two halves of the ring, and is not capable of becoming deformed at the edges.

Dimensions in millimetres

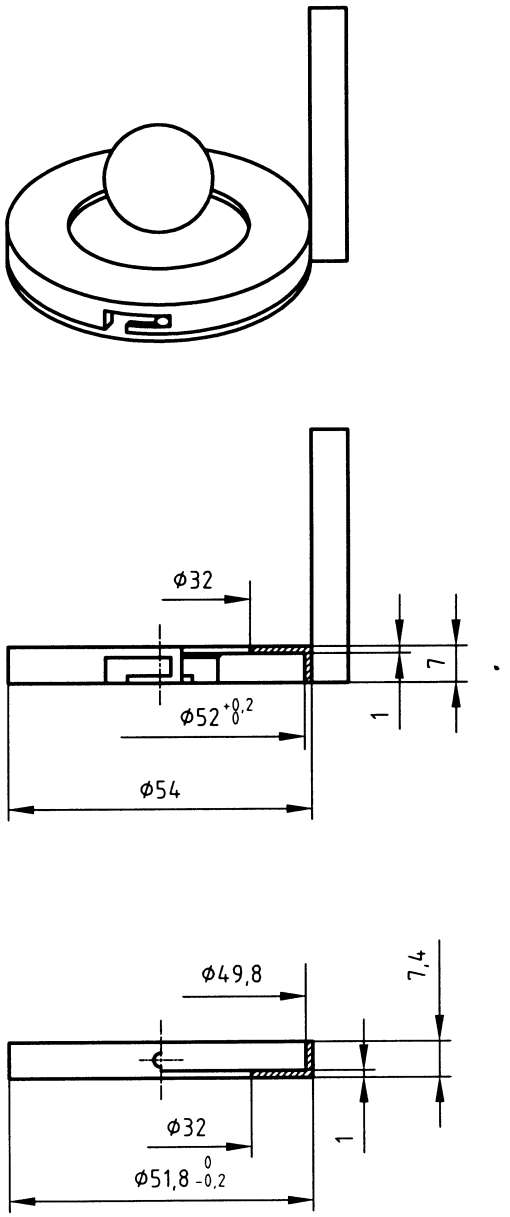


Figure F.1: Ring in accordance with Wilhelmi

F.5 Procedure

Suspend the ring, after preparation as in F.4, in the beaker in such a way that its bottom face is situated 50 mm above the bottom of the beaker. Pour the test liquid into the beaker up to a height of 50 mm above the top face of the ring at a temperature of approximately 5 °C or 30 °C respectively according to the test liquid used (see Table F.1). Place the ball in the test liquid but not on the test specimen. Suspend the thermometer in the beaker in such a way that its bottom end lies flush with the bottom face of the ring, but does not touch either the ring or the beaker.

The type of test liquid and the initial temperature will depend on the softening point of the sample and are listed in Table F.1.

Table F.1: Test conditions

Softening point in accordance with Wilhelmi	Test liquid	Initial temperature
Up to 80 °C	Freshly boiled distilled water	5 °C
Over 80 °C	Glycerine	30 °C

NOTE: Freshly boiled distilled water should be used as otherwise the test results may be affected by air bubbles. The glycerine is still so viscous at temperatures below 50 °C that streaks are formed during the heating process. However, the prescribed uniform temperature rise ensures that no difficulties will occur at a temperature above 60 °C.

After immersion of the ball leave the beaker standing for 10 min at room temperature (18 °C to 28 °C) on the beaker heating device, which has not yet been switched on. After these 10 min place the ball on the test specimen in the middle of the ring, with the aid of the tongs or tweezers.

Heat the beaker in such a way that the temperature of the test liquid increases uniformly at a rate of 5 °C per minute, with non-turbulent stirring. Use the first few minutes to adjust the rate of temperature rise. At a temperature which is at least 15 °C below the softening point of the sample, adjust the rate of the temperature rise with sufficient accuracy to ensure that the further rate of temperature rise from this point onwards takes place at a rate of 5 °C per 60 s ± 5 s. Deviations shall only occur within the range of these ± 5 s and shall even then not be compensated for during the progress of the test.

As the temperature increases, the test specimen becomes more cambered in a downward direction under the weight of the ball. At the instant when either the test specimen or the ball comes into contact with the bottom of the beaker read off the temperature to the nearest 0,5 °C.

Test the second specimen in a second heating process.

If the temperatures measured on the two test specimens differ from one another by more than the permissible 2 °C then repeat the test on two new test specimens.

Carry out the test procedure within 48 h of test specimen preparation.

F.6 Expression of the result

With reference to this test method, report the mean value of the two measurements, rounded to the nearest 1 °C. This represents the softening point in accordance with Wilhelmi.

Annex G (normative)

Thermoplastics – Test method for determining the heat stability

G.1 Principle

The method is intended for the determination of the heat stability of a thermoplastic road marking material under prescribed conditions. The test is designed to simulate the heating conditions which occur during normal application operations.

G.2 Summary

The thermoplastic material is melted and then heated for 6 h at application temperature. Determinations, such as chromaticity co-ordinates *x,y* and luminance factor, softening point, indentation value, Tröger wear and UV ageing are then performed as required.

G.3 Apparatus

a) Heating equipment, suitable for heating the sample up to a temperature of about 220 °C and maintaining this temperature ± 2 °C;

b) paddle stirrer, electrically driven and controlled to rotate at 100 r/min ± 10 r/min. The shaft of the stirrer is a 10 mm diameter rod of suitable length fitted with a “double blade” paddle of 55 mm length, 20 mm depth and 1 mm thickness (see Figures G.1, G.2 and G.3);

c) thermometer, measuring range up to 250 °C with 1 °C divisions and an accuracy of ± 1 °C;

d) one litre paint containers with rim, made of tin, aluminium, glass or stainless steel, inner diameter 100 mm and height 130 mm. Use glass for products containing hard coarse aggregate. Aluminium foil to cover the container during heating;

e) spatula, or other suitable tool for stirring the marking material;

f) dividing tool (if required) e.g. hammer or sledge-hammer.

G.4 Preparation of sample

G.4.1 Division of sample

Divide the thermoplastic material where necessary using a hammer or sledge-hammer. To facilitate this process, the sample may be frozen in a freezing cabinet for at least a couple of hours (or overnight) to obtain a more brittle consistency before being divided into smaller pieces with a hammer.

During this operation protective eyewear shall be worn. The sample may be covered with a cloth to prevent danger from flying fragments.

After division, remove pieces, with a total mass of 1,7 kg, at random from various parts of the interior of the sample.

G.4.2 Heating

Place the sample in the paint containers for heating. Place the container with the sample in a thermostatically regulated heating mantle for heating to the application temperature. Place the stirrer in the centre of the container, 15 mm above the bottom of the container. Place the thermometer in the sample, just between stirrer and container wall, 50 mm to 60 mm above the bottom of the container. This can normally be done when the test sample has reached a temperature of approximately 150 °C. Whilst being brought up to temperature stir the sample continuously. Cover the container with the sample with foil during this heating period. A suitable stirring speed is 100 r/min. Heating from 150 °C to the test temperature (200 °C ± 2 °C or ± 2 °C of the maximum specified application temperature) should not take more than approximately 1,5 h.

When the sample has reached the required temperature and is fully homogenized, maintain test conditions for 6 h. Switch off the heating mantle and leave the container and sample to cool to room temperature in the mantle.

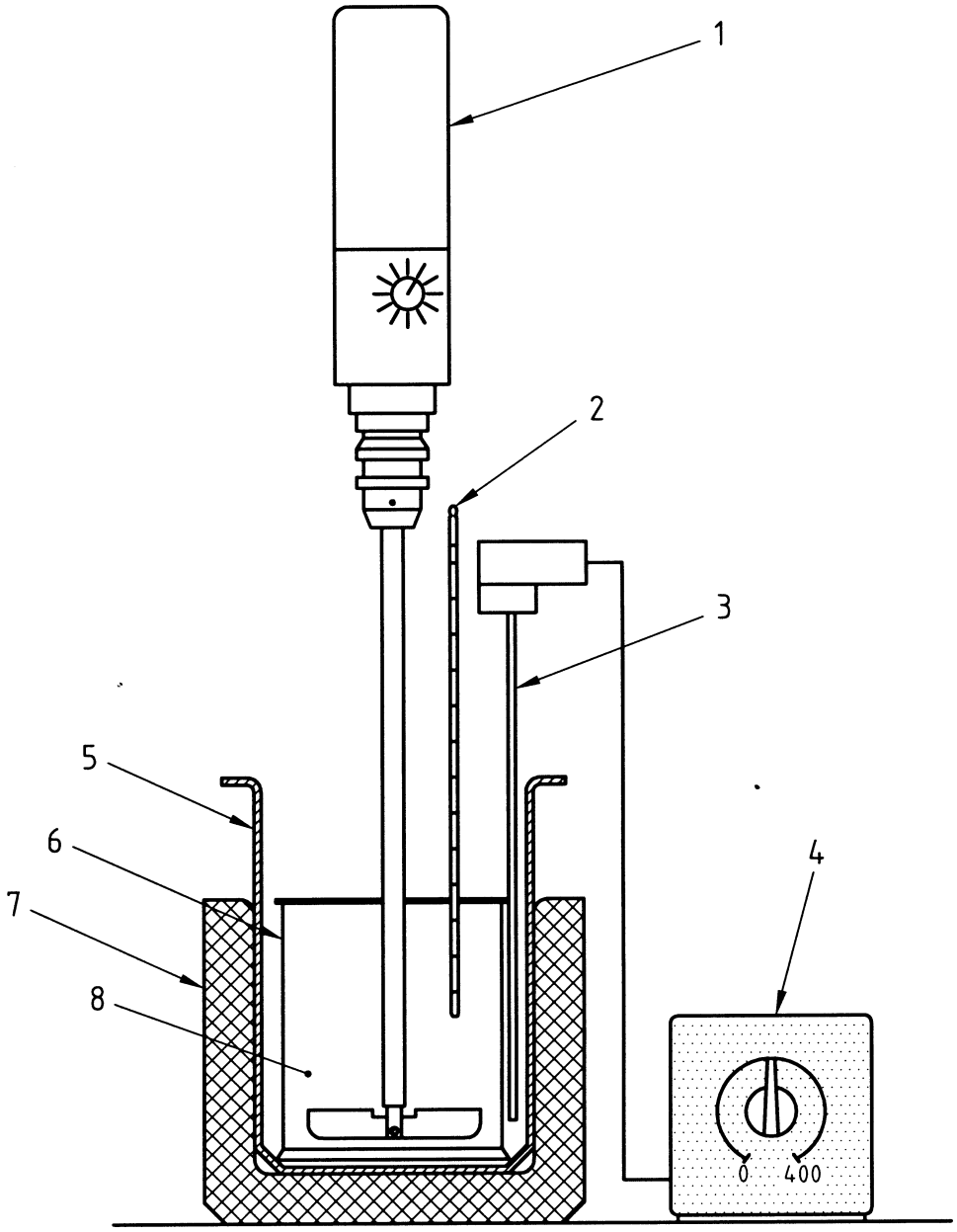
A temperature above the required test temperature can be accepted for short periods of time but these shall not total more than 20 min over the test period. The temperature shall never exceed the maximum temperature given by the manufacturer.

G.5 Testing

When the material has cooled to room temperature (normally overnight), carry out determinations for the following parameters:

a) chromaticity co-ordinates *x,y* and luminance factor β;
b) indentation;
c) Tröger wear;
d) UV ageing;
e) softening point.

For each test, the preparation of the sample and the testing is carried out according to the method in the appropriate annex. The results are reported and compared, where appropriate, with results from samples which have not been subjected to the heat stability test.



Key

1 Stirrer
2 Thermometer
3 Temperature transmitter
4 Temperature regulator
5 Glass vessel
6 1 l container
7 Heating mantle
8 Sample

Figure G.1: Equipment for heating the thermoplastic road marking material

Dimensions in millimetres

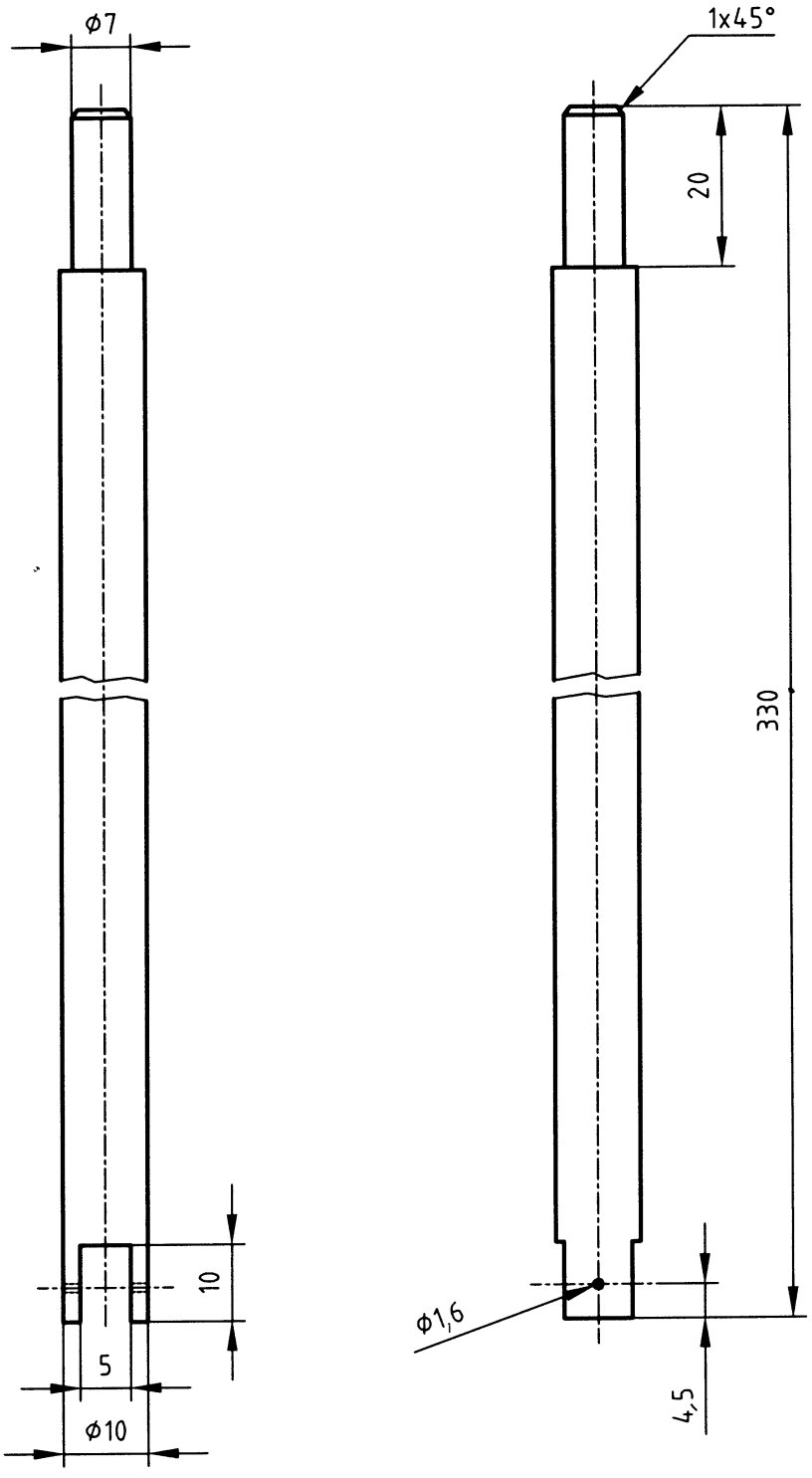


Figure G.2: Stirrer shaft

Dimensions in millimetres

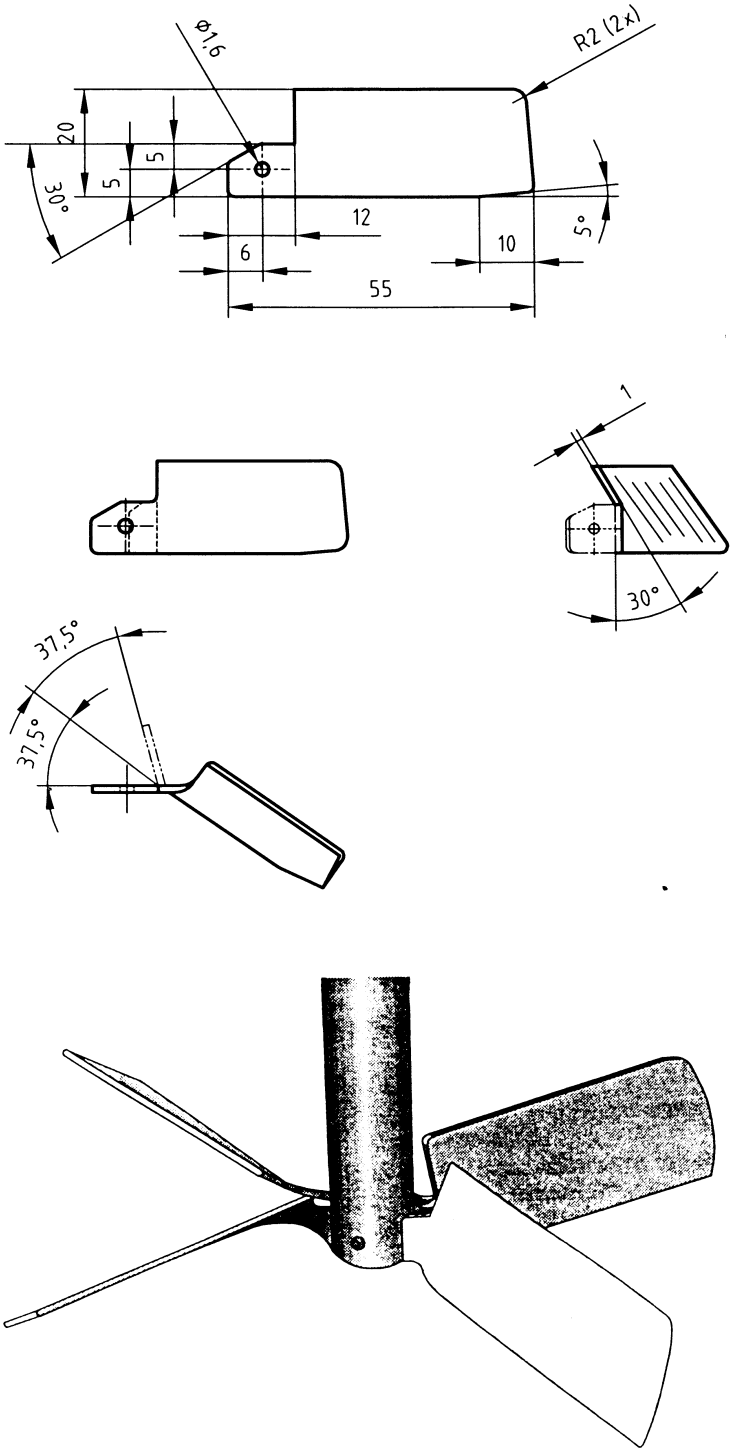


Figure G.3: Stirrer paddle

Annex H (normative)

Thermoplastics – Test method for determining the cold impact resistance

H.1 Principle

The principle is to measure the resistance of thermoplastic materials, which have been stored at cold temperatures, to the impact of a falling steel ball.

H.2 Apparatus and reagents

a) Hobart mixer model N 50 (electric paddle stirrer), or similar equipment, having a mixing container, capacity 5 l, which can be heated during mixing and which is capable of preventing overheating. Single bladed paddle;

b) thermometer, measuring range 0 °C to 250 °C with an accuracy of ±1 °C;

c) cylindrical spring moulds:

- internal diameter: 50 mm ± 0,5 mm;
- depth: 25 mm ± 0,3 mm;

d) glass or metal plate;

e) metal tray containing a cylindrical recess in the base with a diameter of 52 mm and a depth of 2 mm;

f) base plate with centering device;

g) steel balls, either:

- mass 66,8 g ± 0,2 g (approximate diameter 25,4 mm); or
- mass 110 g ± 0,3 g (approximate diameter 30,0 mm);

h) electromagnet;

i) silicon paper strips, length 155 mm, width 25 mm;

j) release oil;

k) brine solution, a solution of 130 g sodium chloride (NaCl) in 1 l of water (for storing specimens at -10 °C);

l) freezer cabinet, capable of reaching -10 °C ± 3 °C;

m) ice and water mixture.

H.3 Procedure

H.3.1 Specimen preparation

Heat the material in the mixing container (in the case of block form material break into pieces no larger than 100 g). Stir constantly and measure the temperature. Continue heating until the material has good flowability.

Do not heat above the supplier's advised maximum safe heating temperature.

Place the silicon paper strips round the inside of the moulds and place the moulds on the metal or glass plate which has been previously treated with release oil.

Fill the moulds with the molten material so that it is slightly above the top level of the moulds. Allow the specimens to cool to ambient temperature and then level off the top surface of the moulds using a heated knife. Remove the specimens from the moulds and immerse them for 3 h in a suitable container filled with a mixture of ice and water at 0 °C or in a freezing cabinet at -10 °C ± 3 °C.

H.3.2 Test at 0 °C

Remove a specimen from the container and place it, with the levelled face downwards, into the recess of the metal tray. Fill the tray with ice and water at 0 °C to the level of the upper surface of the specimen.

With the aid of the electromagnet allow the steel ball of 66,8 g to fall onto the centre of the specimen from a height of 2,00 m (measured from the top surface of the specimen to the underside of the ball). Examine the specimen to see if it has broken or shows evidence of cracking. Test for the presence of hidden cracks by trying to break the specimen by hand. Repeat the procedure until 10 specimens, prepared from the same material, have been tested. Record the number of specimens which have not broken or cracked.

H.3.3 Test at -10 °C

Remove a specimen from the freezing cabinet and place it, with the levelled face downwards, into the recess of the metal tray. Fill the tray with brine solution at -10 °C to the level of the specimen. Test as in H.3.2 but using the steel ball of either 66,8 g or 110,0 g.

Annex J (normative)

Thermoplastics – Test method for determining the indentation value

J.1 Principle

The principle is the determination of the indentation value of a thermoplastic road marking material. The indentation value is the time in seconds required for a cylinder with a base area of 100 mm^2 and a force of 515 N to sink 10 mm into the road marking material at a given temperature.

J.2 Summary

A sample of the thermoplastic road marking material is cast in moulds to produce 70 mm test cubes. The test cubes are conditioned in the mould in a water bath.

A cylindrical stamp with a cross-section of 100 mm^2 is applied perpendicular to the sample surface and loaded with a force of 525 N. The indentation depth of the test stamp varies with time and is recorded.

The time taken to reach 10 mm indentation is recorded. Normally, determinations are carried out on two samples.

J.3 Apparatus

a) Indentation load equipment, with test stamp, dial gauge calibrated in 0,1 mm divisions and water bath with a capacity of 7,5 l (see Figure J.1).

The apparatus is designed so that the sample can be subjected by the stamp to a total load of 525 N ± 1 N applied perpendicular to the test surface. The loading shaft itself contributes a force of 25 N and the mass acting on the sample surface a further 500 N ± 0,9 N; the total mass acting on the sample is 53,5 kg ± 0,1 kg;

b) test stamp, consisting of a steel cylinder with a flat bottom having an area of 100 mm^2 (corresponding to a diameter of 11,3 mm ± 0,1 mm). The mantle and bottom surface of the stamp are ground to a high finish;

c) dial gauge, with graduations of 0,1 mm and an accuracy of ± 0,1 mm;

d) water bath, capable of controlling the temperature at the required test temperature ± 0,5 °C.

The entire apparatus shall be placed on a flat surface:

e) square steel mould, inner size 70 mm ± 1 mm, with base plate and fixing device, (see figure J.2);

f) apparatus for heating the sample (see figure G.1);

g) one litre paint container (see clause G.3);

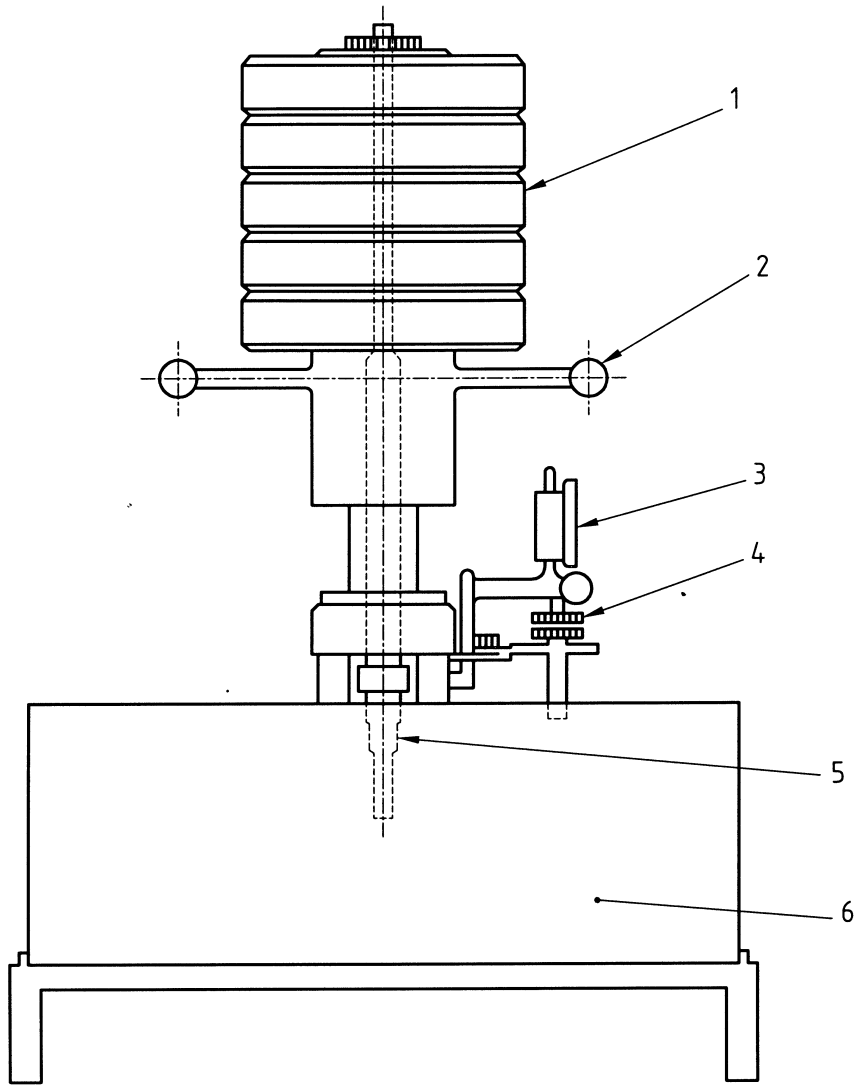
h) stopwatch, with graduations of 0,1 s and with an accuracy of ± 0,1 s;

i) glycerine for lubricating the mould and baseplate;

j) dividing tool (see clause G.3);

k) spatula or other suitable tool for stirring the sample;

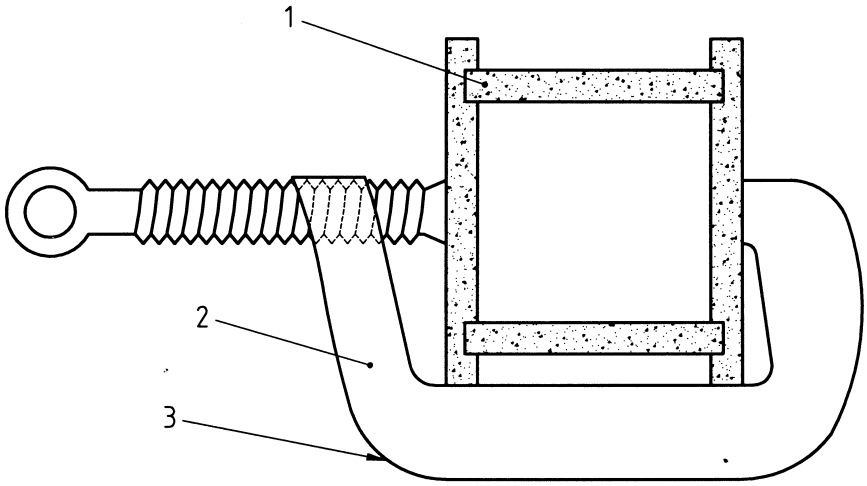
l) oven, capable of being controlled at any temperature up to 200 °C.



Key

1 Weights
2 Raising and lowering mechanism
3 Dial gauge
4 Fine adjustment
5 Test stamp
6 Water bath

Figure J.1: Indentation load apparatus



Key

1 Mould
2 Fixing device
3 Steel plate

Figure J.2: Steel mould with fixing device

J.4 Preparation of the sample

J.4.1 Division of sample

Divide the thermoplastic road marking material as described in G.4.1.

J.4.2 Heating and casting of test cubes

Carry out the heating as described in G.4.2. When the sample has reached the required temperature and finally homogenized with a spatula, cast it in the test cubes.

Pour the heating sample evenly, with a small excess, into the mould which has been previously lubricated with glycerine. After the test cube has cooled somewhat, use a tool, such as a spatula, to produce a small elevation in the centre of the top surface. The elevation shall be sufficiently big so that a flat surface is formed when the test cube has cooled completely.

When the test cube has reached room temperature remove it from the mould, turn so that one side is at the bottom and remount in this way in the mould. It is important that the test cube rests completely on the base plate.

J.4.3 Conditioning

After being turned in the mould and firmly re-fixed, place the test cube in the water bath and condition at 20 °C ± 0,5 °C for at least 1 h (other testing temperatures may apply). Prepare two cubes and carry out the test on both cubes.

J.5 Testing

Place the test cube under the test stamp, with the total load moved upwards with the aid of the raising and lowering device. Apply the loading shaft alone (force 25 N) to the surface of the test cube at a distance of approximately 20 mm from the edge of the cube. When this load is stabilized set the dial gauge to zero with the fine adjustment. Apply the total load (525 N) to the shaft by slowly turning the raising and lowering device and turning the arm 2 to 3 times so that the load is completely free, and start the stopwatch. Record the time for 10 mm indentation.

Carry out the testing procedure within 48 h of test cube preparation.

J.6 Calculation

The time taken for 10 mm indentation is specified in seconds for each test cube. The arithmetic mean is calculated.

J.7 Interpretation of the results

If the deviation between individual values and the mean does not exceed 5 s for means less than 50 s, or 10 % for means greater than 50 s, then the values are approved.

If the deviation is greater, test two further cubes and calculate the arithmetic mean of all the values. If the deviation between this mean and any individual value is greater than 5 s or 10 % respectively, reject the value and calculate a new mean from the approved values.

J.8 Report

The test report shall include the following information:

a) that testing has been performed according to this method;

b) the test temperature;

c) the time for 10 mm indentation in seconds, the mean and all approved values.

Annex K (normative)

Thermoplastics and cold plastics – Test method for determining the Tröger wear

K.1 Principle

The principle of the method is the determination of the wear resistance of thermoplastics and cold plastics road marking materials. Wear is produced in a Tröger apparatus on a sample which is applied to a Marshall specimen. The test is carried out at a temperature of -10 °C.

K.2 Summary

The heated, homogenized thermoplastics or prepared cold plastics material is applied to a Marshall specimen and is conditioned at -10 °C for 15 h to 20 h. The sample is then mounted in a Tröger apparatus.

Wear is produced by a needle gun driven by compressed air. During testing air, at -10 °C, is blown continuously across the sample.

The mass of abraded material is recorded by weighing the test sample before and after the test. The volume loss is then calculated.

Normally, testing is carried out on three Marshall test specimens to which material has been applied.

K.3 Apparatus

a) A flat steel plate;

b) Marshall specimens, with paving grade bitumen 160/220, binder content 6,7 % ± 0,3 % by mass, maximum aggregate size 4 mm and voids content 4,4 % ± 1,0 % by volume. The aggregate used should have a Nordic Abrasion Value of not more than 9. The specimens are sawn to approximately 30 mm thick;

c) steel moulds and scraper, for application of the sample to the Marshall specimens (see Figure K.1);

d) sample heating equipment, as in Figure G.1;

e) one litre paint containers, as in clause G.3;

f) spatula, or other suitable tool for stirring the molten material;

g) dividing tool, see clause G.3;

h) oven, capable of being set to any temperature up to approximately 200 °C;

i) freezing cabinet, capable of being set to any temperature down to approximately -15 °C and to keep the required temperature within ± 2 °C;

j) laboratory balance, with an accuracy of 0,1 g;

k) Tröger apparatus, placed in a sound-insulated cabinet (see Figure K.2);

l) cold air device, providing a continuous supply of cold air at -10 °C ± 2 °C;

m) glycerine, for lubricating the mould.

K.4 Preparation of sample - thermoplastics

K.4.1 Carry out the division of the sample as described in G.4.1.

K.4.2 Carry out the heating as described in G.4.2. When the sample has reached the required temperature, homogenize with a spatula and apply the material to a Marshall specimen using a mould and scraper (see Figure K.1). Heat the mould and scraper to a temperature between 150 °C and 180 °C. Lubricate the inside of the mould with glycerine. Place the clean, dry Marshall specimen flat with the sawn surface up. Place the hot mould over the Marshall specimen, cast the material and scrape off along the top of the mould with the scraper. After approximately 30 s remove the mould by twisting it.

After application allow the sample to cool to room temperature.

Apply approximately 3 mm of material. Other thicknesses can be used like 1,5 mm for spray plastics.

Carry out the test on three samples.

K.5 Preparation of sample – cold plastics

Prepare the cold plastic material as recommended by the supplier. Apply the material to the Marshall specimens using a mould and a scraper. Lubricate the inside of the mould with glycerine. Place the clean, dry Marshall specimen flat with the sawn surface up. Place the mould over the Marshall specimen, cast the material and scrape it off along the top of the mould with the scraper.

Allow the samples to cure for a period specified by the supplier. Remove the mould by twisting it.

The thickness of the mould depends on the material and shall as recommended by the supplier.

Carry out the test on three samples.

K.6 Procedure

K.6.1 Weigh the sample (M_i) and fix it in the Tröger apparatus (see figure K.2). Adjust the needle gun so that the distance between the needles and the surface of the sample is 5 mm. Set the rotating table with the sample in motion. The rotation speed shall be 30 r/min. Close the door of the sound-insulated cabinet and start the Tröger apparatus.

Process the samples of 3 mm thickness for 16 periods of 40 s (at an air pressure of 500 kPa) with a 32 s interval between each period. At the same time blow cold air at -10 °C across the sample.

> NOTE: Using suitable automation the Tröger apparatus can be programmed to operate without manual supervision.

Process the samples of 1,5 mm thickness (spray plastics) for 5 periods of 40 s. Processing may be continued for 16 periods if required.

K.6.2 When testing has been completed, remove the sample, brush off thoroughly and weigh (M_s).

K.7 Calculation

Wear, W, is expressed in cubic centimetres (cm^3) and is calculated as follows:

$$W = \frac{M_i - M_s}{\rho}$$

where:

M_i is the mass of original test specimen in grams (g);
M_s is the mass of the test specimen in grams (g) after testing;
ρ is the density of the tested material in grams per cubic centimetres (g/cm^3);

and it is expressed to the nearest 0,1 cm^3.

Calculate the arithmetic mean for the three samples.

K.8 Interpretation of the results

If the deviation between individual values and the mean does not exceed 0,3 cm^3 for means less than 2,5 cm^3, or 10 % for means greater than 2,5 cm^3, the values are approved.

If the deviation is greater, test two further samples and calculate the arithmetic mean of all the values. If the deviation between this mean and any individual value is greater than 0,3 cm^3 or 10 % respectively, reject the value and calculate a new mean from the approved values.

K.9 Report

The test report shall include the following information:

a) that testing has been performed in accordance with this method;

b) the number of test cycles (5 or 16);

c) the mass of abraded material ($M_i - M_s$), in grams, for all approved values;

d) the density in grams per cubic centimetre of tested material and the testing method used for its determination;

e) the wear in cubic centimetres, mean value and all approved values.

Dimensions in millimetres

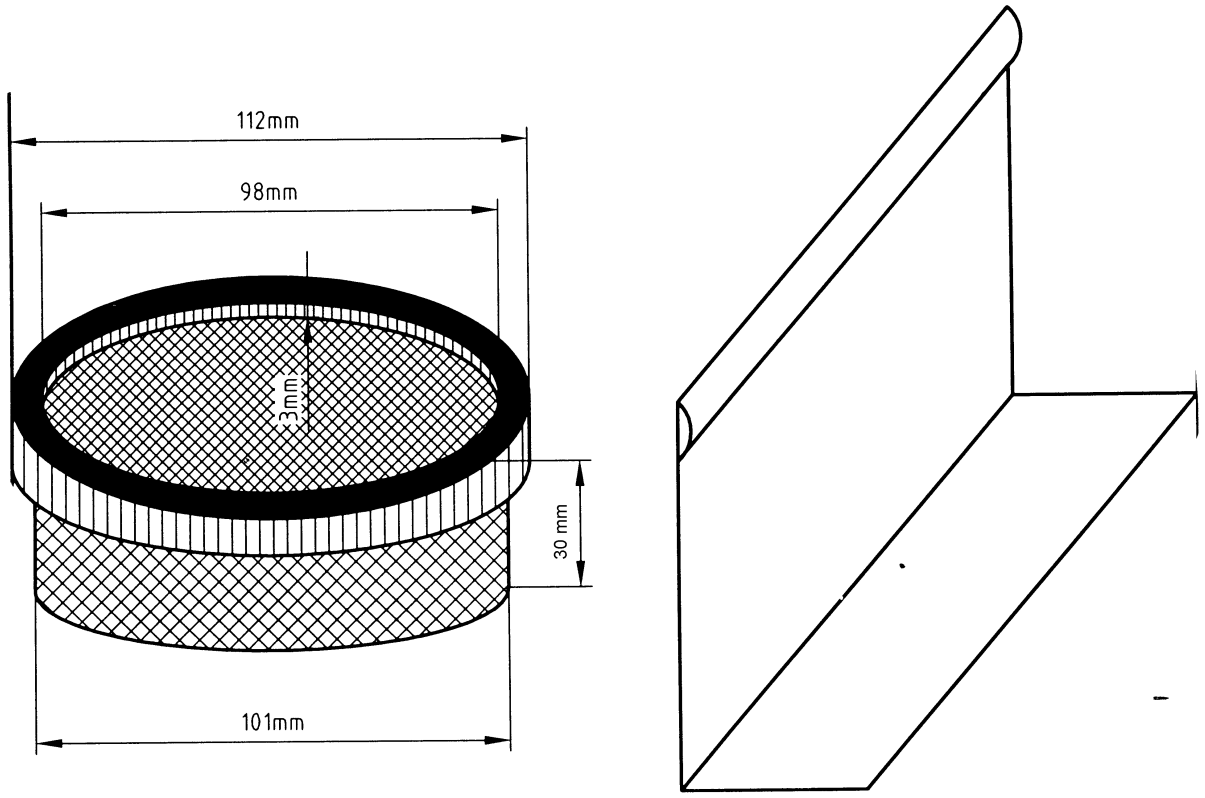
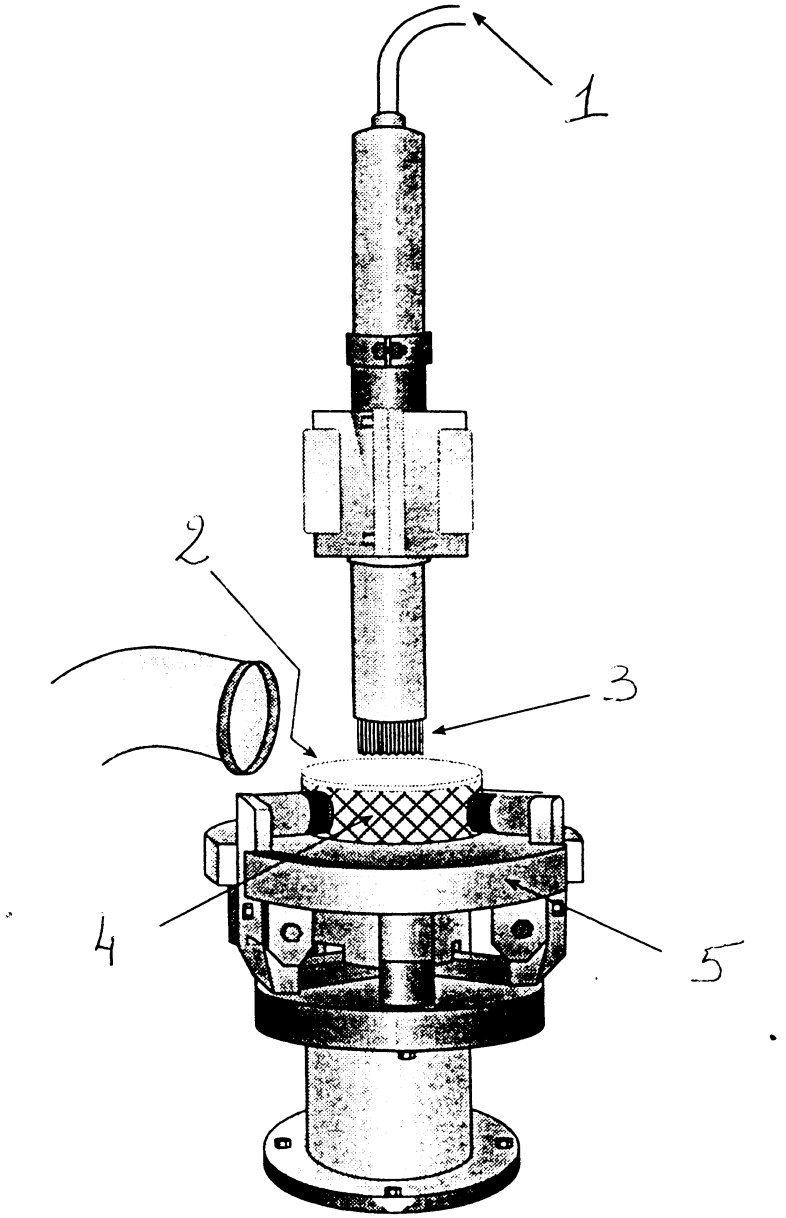


Figure K.1: Mould and scraper for applying material to a Marshall specimen



Key

1 Compressed air for driving gun
2 Cold air for cooling the sample surface
3 Needles
4 Sample
5 Rotating table

Figure K.2: General diagram of Tröger apparatus

Bibliography

ISO/CIE 10526	1991	CIE standard colorimetric illuminants
CIE Publication 17.4	1986	International lighting vocabulary

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