BRITISH STANDARD

BS EN
1338:2003

Concrete paving blocks — Requirements and test methods

The European Standard EN 1338:2003 has the status of a British Standard

ICS 93.080.20

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 1338:2003.

EN 1338 is a candidate "harmonized" European Standard and fully takes into account the requirements of the European Commission mandates M/119, *Floorings*, and M/122, *Roof Coverings*, given under the EU Construction Products Directive (89/106/EEC), and intended to lead to CE marking. The date of applicability of EN 1338 as a harmonized European Standard, i.e. the date after which this standard may be used for CE marking purposes, is subject to an announcement in the *Official Journal of the European Communities*.

The Commission in consultation with the Member States have agreed a transition period for the co-existence of harmonized European Standards and their corresponding national standard(s). It is intended that this period will comprise a period, usually nine months, after the date of availability of the European Standard, during which any required changes to national regulations are to be made, followed by a further period, usually of 12 months, for the implementation of CE marking. At the end of this co-existence period, the national standard(s) will be withdrawn.

EN 1338 is the subject of transitional arrangements agreed under the Commission mandate. In the UK, the corresponding national standard is:

— BS 6717:2001, *Precast, unreinforced concrete paving blocks — Requirements and test methods*;

and based on this transition period of twenty-one months, BS 6717:2001 would be withdrawn in February 2005.

NOTE This date is approximate. Users of this standard should contact BSI Customer Services for confirmation of withdrawal.

The UK participation in the preparation of EN 1338:2003 was entrusted by Technical Committee B/507, Paving units, kerbs, screeds and in-situ floorings, to its Subcommittee, B/507/1, Paving units and kerbs — (precast concrete), which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/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.

Attention is drawn to National Annex NA (informative), which contains additional information and advice on the use of different performance classes for users in the UK.

Cross-references

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 29 May 2003

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EUROPEAN STANDARD

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English version

Concrete paving blocks - Requirements and test methods

Pavés en béton - Prescriptions et méthodes d'essai

Pflastersteine aus Beton - Anforderungen und *Prüfverfahren*

This European Standard was approved by CEN on 16 October 2002.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (EN 1338:2003) has been prepared by Technical Committee CEN/TC 178 "Paving units and kerbs", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2003, and conflicting national standards shall be withdrawn at the latest by February 2005.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with the Construction Products Directive see informative Annex ZA, which is an integral part of this document.

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, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

No existing European Standard is superseded.

The annexes B, C, D, E, F, G, H, I and J are normative, the annexes A, K and ZA are informative.

1 Scope

This European Standard specifies materials, properties, requirements and test methods for unreinforced cement bound concrete paving blocks and complementary fittings. It is applicable to precast concrete paving blocks and complementary fittings for pedestrian use, vehicular use and roof coverings, e.g. footpaths, precincts, cycle tracks, car parks, roads, highways, industrial areas (including docks and harbours), aircraft pavements, bus stations, petrol filling stations.

In case of regular use of studded tyres additional requirements are sometimes needed.

This standard does not deal with the tactility or visibility of blocks nor with permeable blocks.

This standard provides for the product marking and the evaluation of conformity of the product to this European Standard.

2 Normative references

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

EN 10083-2, *Quenched and tempered steels — Part 2: Technical delivery conditions for unalloyed quality steels.*

EN 13369, *Common rules for precast concrete products.*

EN ISO 4288, *Geometric product specification (GPS) - Surface texture: Profile method - Rules and procedures for the assessment of surface texture (ISO 4288:1996).*

EN ISO 6506-1, *Metallic materials - Brinell hardness test - Part 1: Test method (ISO 6506-1:1999).*

EN ISO 6506-2, *Metallic materials - Brinell hardness test - Part 2: Verification and calibration of testing machines (ISO 6506-2:1999).*

EN ISO 6506-3, *Metallic materials - Brinell hardness test - Part 3: Calibration of reference blocks (ISO 6506-3:1999).*

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD).*

ISO 4662, *Rubber — Determination of rebound resilience of vulcanizates.*

ISO 7619, *Rubber — Determination of indentation hardness by means of pocket hardness meters.*

ISO 7873, *Control charts for arithmetic average with warning limits.*

ISO 7966, *Acceptance control charts.*

ISO 8486-1, *Bond abrasives — Determination and designation of grain size distribution — Macrogrits F4 to F220.*

3 Terms and definitions

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

3.1
arris
part of a block where two faces meet. It can be bevelled, rounded, chamfered, radiussed or splayed

3.2
concrete paving block
precast concrete unit used as a surfacing material that satisfies the following conditions:

— at a distance of 50 mm from any edge, any cross-section does not show a horizontal dimension less than 50 mm;

— its overall length divided by its thickness is less than or equal to four.

NOTE These two conditions are not applicable to complementary fittings.

3.3
complementary fitting
unit, sometimes a part of a block, which is used to infill and enable an area to be completely surfaced

3.4
permeable paving block
block intended by its structure to allow the passage of water through the block

3.5
overall length
longer side of the rectangle with the smallest area able to enclose the block excluding any spacer nibs

3.6
overall width
shorter side of the rectangle with the smallest area able to enclose the block excluding any spacer nibs

3.7
thickness
distance between the upper face and the bed face of the block

3.8
spacer nibs
small protruding profiles on a side face of a block

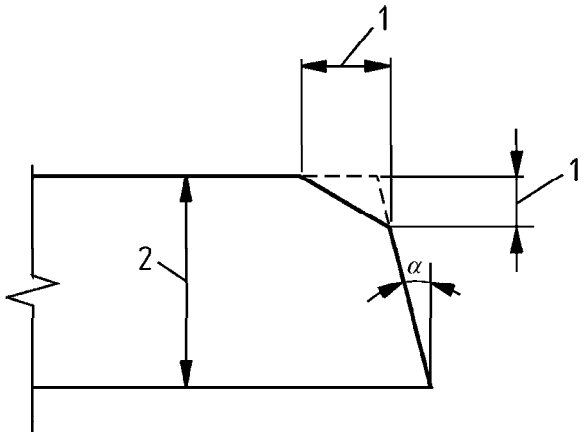
3.9
upper face
surface intended to be seen when in use

3.10
bed face
surface generally parallel to the upper face and in contact with the bedding after laying

3.11
facing layer
layer of concrete on the upper face of a block of different material and/or properties to the main body or backing layer

NOTE To be distinguished from wipe, being a fine cement mortar or slurry applied to the surface of the block.

3.12
draw
intended angle of the side face from the vertical plane over the full height of a block as shown in Figure 1



Key

1 Chamfer 2 Thickness α Draw

Figure 1 — Example of chamfer and draw

3.13
chamfer
bevelled arris, as shown in Figure 1

3.14
work dimension
any dimension of a block specified for its manufacture to which the actual dimension should conform within specified permissible deviations

3.15
secondary processing
manufacturing process to texture the whole block or any surface, carried out after basic manufacture before or after hardening

3.16
actual dimension
dimension of a block as measured

3.17
chased side face
side face of a concrete paving block, having a recessed profile

3.18
skid resistance
ability to resist relative movement between a vehicle tyre and the trafficked concrete paving block surface

3.19
slip resistance
ability to resist relative movement between a pedestrian foot and the trafficked concrete paving block surface

3.20
format
work dimensions of a block, specified in order of overall length, overall width and thickness

3.21
wipe
fine cement mortar or slurry applied to the surface of the units

4 Requirements for materials

4.1 General

Only materials with suitability established in terms of their properties and performance shall be used in the manufacture of concrete paving blocks.

The suitability requirements of the materials used shall be given in the manufacturer's production control documentation.

Where, by conformity with relevant specifications, the properties and performance of materials have been demonstrated, further testing need not be performed.

A reference scheme for materials inspection is given in annex A.

4.2 Asbestos

Asbestos, or materials containing asbestos, shall not be used.

5 Requirements for products

5.1 General

The performance requirements of concrete paving blocks are defined by classes which have associated marking designations.

Blocks may be produced with a single concrete throughout or with different facing and backing layers.

When blocks are produced with a facing layer this shall have a minimum thickness of 4 mm over the area declared by the manufacturer, when measured in accordance with annex C. Isolated particles of aggregate protruding into the facing layer shall be ignored. The facing layer shall be an integral part of the block.

An arris described as square may be bevelled or rounded, its horizontal or vertical dimensions shall not exceed 2 mm.

A bevelled arris exceeding 2 mm shall be described as chamfered. Its dimensions shall be declared by the manufacturer.

Blocks may be produced with functional and/or decorative profiles, which shall not be included in the work dimensions of a block.

The surface of blocks may be textured, secondary processed or treated chemically; these finishes or treatments shall be described and declared by the manufacturer.

5.2 Shape and dimensions

5.2.1 General

All references to dimensions in this subclause are to work dimensions.

The conformity criteria corresponding to each requirement taken separately are given in 6.3.8.1. The dimensions and deviations shall be measured according to annex C.

5.2.2 Work dimensions

The work dimensions shall be stated by the manufacturer.

5.2.3 Spacer nibs, draw or chased and profiled side faces

Blocks may be produced with spacer nibs, a draw or chased and profiled side faces. When these are provided, the manufacturer shall declare their work dimensions.

NOTE The size of the space allocated to the block should include an allowance for joints and deviations.

5.2.4 Permissible deviations

The permissible deviations on the manufacturer's declared work dimensions are given in Tables 1, 2 and 3.

Table 1 — Permissible deviations

Block thickness	**Length**	**Width**	**Thickness**
Mm	mm	mm	mm
< 100	± 2	± 2	± 3
≥ 100	± 3	± 3	± 4
The difference between any two measurements of the thickness of a single block shall be ≤ 3 mm.			

For non-rectangular blocks the deviations of the other dimensions shall be declared by the manufacturer.

When the length of the diagonals exceeds 300 mm, the maximum permissible differences between the measurement of the two diagonals of a rectangular block are given in Table 2.

Table 2 — Maximum differences

Class	Marking	Maximum difference mm
1	J	5
2	K	3

When the maximum dimension of a block exceeds 300 mm, the deviations for flatness and bow given in Table 3 shall apply to an upper face intended to be plane. When the upper face is not intended to be plane, the manufacturer shall supply the information on deviations.

Table 3 — Deviations of flatness and bow

Length of gauge Mm	Maximum convex mm	Maximum concave mm
300	1,5	1,0
400	2,0	1,5

NOTE For special fields of application such as airports, other deviations can be required.

5.3 Physical and mechanical properties

5.3.1 General

The blocks shall conform to the following requirements at the time they are declared suitable for use by the manufacturer.

When complementary fittings cannot be tested according to this standard, they are considered to conform to this standard, provided they have at least the same concrete quality as blocks complying with this standard.

5.3.2 Weathering resistance

5.3.2.1 Test method

The weathering resistance is determined by tests according to annex D for freeze-thaw resistance or annex E for water absorption and to the conformity criteria of 6.3.8.2.

5.3.2.2 Performance and classes

The blocks shall conform to the requirements in Table 4.1 or Table 4.2.

Recommendations as to the class(es) of weathering resistance required to ensure durability for that country, for the uses for which the product is put on the market, may be made at a national level.

Table 4.1 — Water absorption

Class	Marking	Water absorption % by mass
1	A	no performance measured
2	B	≤ 6 as a mean

Where specific conditions exist such as frequent contact of surfaces with de-icing salts under frost conditions, the requirements defined in Table 4.2 may have to be fulfilled.

Table 4.2 — Resistance to freeze-thaw with de-icing salts

Class	Marking	Mass loss after freeze/thaw test kg/m²
3	D	≤ 1,0 as a mean with no individual value > 1,5

5.3.3 Tensile splitting strength

5.3.3.1 Test method

The characteristic tensile splitting strength *T* shall be determined by testing according to annex F and to the conformity criteria given in 6.3.8.3.

5.3.3.2 Performance

The characteristic tensile splitting strength *T* shall not be less than 3,6 MPa. None of the individual results shall be less than 2,9 MPa, nor have a failure load less than 250 N/mm of splitting length.

5.3.3.3 Durability of strength

Under normal exposure conditions of use precast concrete blocks will continue to provide satisfactory strength, provided they conform to 5.3.3.2 and are subject to normal maintenance.

5.3.4 Abrasion resistance

5.3.4.1 Test method

Abrasion resistance is determined by the Wide Wheel Abrasion test (see annex G), , or as an alternative by the Böhme test (see annex H). The Wide Wheel Abrasion test is the reference test.

5.3.4.2 Performance and classes

Requirements for abrasion resistance are given in Table 5.

No individual result shall be greater than the required value.

Table 5 — Abrasion resistance classes

Class	Marking	Requirement	
		Measured in accordance with the test method described in annex G	Alternatively measured in accordance with the test method described in annex H
1	F	No performance measured	No performance measured
3	H	≤ 23 mm	≤ 20 000 mm³/5 000 mm²
4	I	≤ 20 mm	≤ 18 000 mm³/5 000 mm²

5.3.5 Slip/skid resistance

5.3.5.1 Conditions

Concrete paving blocks have satisfactory slip/skid resistance provided that their whole upper surface has not been ground and/or polished to produce a very smooth surface.

5.3.5.2 Test method

If in an exceptional case a value for slip/skid resistance is required, the test method as described in annex I shall be used and the minimum slip/skid resistance value shall be declared.

If the surface of a block contains ridges, grooves or other surface features which prevent testing by the pendulum friction equipment, the product is deemed to satisfy the requirements of this standard without testing. Where the block is too small to provide a test area, the manufacturer shall test a larger block having the same surface finish as the block in question.

NOTE The slip/skid resistance value relates to blocks as manufactured and helps to ensure adequate slip/skid resistance on installation.

5.3.5.3 Durability of slip/skid resistance

Under normal conditions of use precast concrete blocks provide satisfactory slip/skid resistance during the working life of the product, provided they are subjected to normal maintenance and unless a major proportion of aggregates which polish excessively have been exposed on the upper face.

NOTE The development of a performance based test method for the durability of slip/skid resistance is proceeding in TC 178 WG4.

5.3.6 Fire performance

5.3.6.1 Reaction to fire

Concrete paving blocks are Class A1 reaction to fire without testing.[1)]

[1)] Reference is made to the Commission Decision 96/603/EC, as amended.

5.3.6.2 External fire performance

Concrete paving blocks used as roof covering are deemed to satisfy the requirements for external fire performance without the need for testing.[2)]

5.3.7 Thermal conductivity

If concrete blocks are intended to contribute to the thermal performance of an element, then the manufacturer shall declare the thermal conductivity using design data from EN 13369.

5.4 Visual aspects

5.4.1 Appearance

The upper faces of the concrete paving blocks shall not exhibit defects such as cracking or flaking when examined in accordance with annex J.

In the case of two-layer blocks and when examined in accordance with annex J there shall be no delamination (i.e. separation) between the layers.

NOTE When efflorescence occurs it is not deleterious to the performance of the blocks in use and is not considered significant

5.4.2 Texture

In the case of blocks produced with special surface textures, the texture shall be described by the manufacturer.

If examined in accordance with annex J, conformity shall be established if there are no significant differences in texture to any samples supplied by the manufacturer and approved by the purchaser.

NOTE Variations in the texture consistency of the blocks can be caused by unavoidable variations in the properties of the raw materials and by variations in hardening and are not considered significant.

5.4.3 Colour

Colours may be provided in a facing layer or throughout the block at the manufacturer's discretion.

If examined in accordance with annex J, conformity shall be established if there are no significant differences in colour to any samples supplied by the manufacturer and approved by the purchaser.

NOTE Variations in the colour consistency of the blocks can be caused by unavoidable variations in the shade and properties of the raw materials and by variations in hardening and are not considered significant.

6 Evaluation of conformity criteria

6.1 General

For the purpose of testing, the manufacturer may group products into families, where it is considered that the value of a selected property is common to all products within that family. Such families are:

1) strength family: blocks manufactured using the same type of materials and production methods, irrespective of dimensions and colours;

[2)] See Commission Decision 2000/553/EC.

NOTE Failure load is dependent upon block thickness

2) surface family: blocks with face mixes having the same main aggregate used in the mix (e.g. natural river gravel, crushed granite, porphyr, basalt or limestone) and the same surface treatment of the finished product, irrespective of dimensions and colours.

6.1.1 Demonstration of conformity

The manufacturer shall demonstrate conformity of his product with the requirements of this standard and with the declared values (levels or classes) for the product properties by carrying out both:

— type testing of the product (see 6.2);

— factory production control (see 6.3), including product testing.

6.1.2 Assessment of conformity

In addition, conformity of the product with this standard may be assessed:

— either by a third party inspecting the manufacturer's type testing and factory production control procedures;

— or by acceptance testing of a consignment at delivery (e.g. in the case of dispute, see annex B).

6.2 Type testing of the product

6.2.1 Initial type testing

Initial type testing shall be performed to demonstrate conformity with this standard at the beginning of the manufacture of a new product type or a family of product types, or setting up a new production line, to confirm that the achieved properties of the product meet the requirements of this standard and the values declared for it by the manufacturer.

Where the product has previously been tested according to this standard (same product, same characteristics, same or more demanding test method and sampling procedure), the result may be used to satisfy initial type testing.

6.2.2 Further type testing

Whenever a change occurs in the raw materials, the proportions used or the production equipment or process, which would change significantly some or all of the properties of the finished product, the type tests shall be repeated for the selected property or properties.

NOTE Examples of major changes:

1) change from natural river gravel to crushed rock aggregates or change of cement type or class;

2) partial substitution of cement by additions.

For abrasion and weathering resistance, type testing shall be repeated periodically with the frequency given in Table 6 even when no change occurs.

Table 6 — Periodically repeated type testing

Property	Frequency
Abrasion (only classes 3 and 4)	Once per year per surface family
Weathering resistance (only class 3)	Once per year per surface family[1)]
[1)] If for a surface family the result of a type test (mass loss) is lower than 50 % of the required value the test frequency may be reduced to once per two years. If for a surface family, routine water absorption testing at the frequency for class 2 products (see 6.3.8.2.) is carried out to demonstrate consistency with blocks submitted to freeze/thaw testing, the required test frequency may be reduced to once per two years. If both conditions are met, the test frequency may be reduced to once per four years.	

6.2.3 Sampling, testing and conformity criteria

The number of blocks to be tested shall be in accordance with Table 7 for the selected property.

Table 7 — Sampling plan and conformity criteria for initial and further type testing

Property	Requirements	Testing method	Number of blocks	Conformity criteria
Visual aspects	5.4	Annex J	20 [1)]	No block shall show cracking, flaking or delamination [2)]
Thickness of facing layer	5.1	C.6 [2)]	8	Each block shall meet the requirements
Shape and dimensions	5.2	Annex C [2)]	8 [1)]	Each block shall meet the requirements for the declared class
Tensile splitting strength and failure load	5.3.3	Annex F	8	No block shall have a tensile strength less than 3,6 MPa nor a failure load less than 250 N/mm
Abrasion resistance (only classes 3 and 4)	5.3.4	Annex G or H	3	Each block shall meet the requirements for the declared class
Slip/skid resistance (only where tested)	5.3.5	Annex I	5	The mean of the five blocks shall be declared
Weathering resistance				
- class 2	5.3.2	Annex E	3	No block shall have a water absorption greater than 6 % by mass
- class 3	5.3.2	Annex D	3	The mean of the three blocks shall not be greater than 1,0 kg/m^2 with no individual result greater than 1,5 kg/m^2
[1)] These blocks may be used for subsequent tests. [2)] C.6 only applies for blocks with a facing layer.				

The type tests shall be carried out in accordance with the reference test methods called up in this standard.

Type testing is normally carried out with the manufacturer's test equipment.

The test results shall be recorded.

6.3 Factory production control

6.3.1 General

The manufacturer shall establish, document and maintain a factory production control system to ensure that the products placed on the market will conform with the specified or declared values.

The factory production control system shall consist of procedures, regular inspection and tests and the utilisation of the results to control raw and other incoming materials, equipment, the production process and the product.

An example of a suitable inspection scheme for factory production control is given in annex A.

The results of inspections requiring action and the results of tests shall be recorded.

The action to be taken when control values or criteria are not met shall be given.

6.3.2 Equipment

All weighing, measuring and testing equipment shall be calibrated and regularly inspected according to the documented procedures, frequencies and criteria.

An inspection scheme for equipment is given in A.1.

6.3.3 Raw and other incoming materials

The specifications of all incoming materials shall be documented.

An inspection scheme for raw materials is given in A.2.

6.3.4 Production process

The relevant features of the plant and production process shall be defined giving the frequency of the inspection checks and tests, together with the criteria required both on equipment and on work in progress.

An inspection scheme for the production process is given in A.3.

6.3.5 Product testing

A sampling and testing plan of products shall be prepared and implemented.

The sample shall be representative of production.

The tests shall be carried out in accordance with the methods called up in this standard or applying alternative test methods with a proven correlation to the standard methods.

The results of testing shall meet the specified conformity criteria (see 6.3.8) and be available.

An example of an inspection scheme for product testing is given in A.4.1.

Switching rules for product testing are given in A.5.

6.3.6 Marking, storage and delivery of products

The marking, storage and delivery control, together with procedures for dealing with non-conforming products (see 6.3.7), shall be documented.

Products may be released before the final test results of factory production control testing are received, if they are subject to a positive recall procedure.

An example of inspection scheme for marking, storage and delivery is given in A.4.2.

6.3.7 Non-conforming products

If the results of the tests on a product are unsatisfactory, the manufacturer shall take the necessary steps in order to rectify the shortcoming.

Products which do not conform to the requirements shall be set aside and marked accordingly.

If any non-conformity of the product is established after delivery, the customer shall be notified.

6.3.8 Product conformity criteria

When the conformity criteria in this clause may be considered either by attributes or variables, the method applied shall be at the manufacturer's discretion.

6.3.8.1 Shape and dimensions

A. Attributes

The conformity of the production with 5.2 shall be assessed for each machine per production day (see sampling according to A.4.1.3). Each of the requirements in 5.2 shall be considered separately.

a) If the sample consists of less than eight blocks (see switching rules in A.5) and each of the requirements in 5.2 for the declared class is complied with by all of the blocks, then the sample and the corresponding production shall be accepted. If not, this sample shall be increased to eight blocks and the procedure given in b) shall apply.

b) If the sample consists of eight blocks and not more than one of the blocks does not conform to any one of the requirements in 5.2 considered separately for the declared class, the sample and the corresponding production shall be accepted. If not, this sample shall be increased to 16 blocks and the procedure given in c) shall be applied.

c) If the sample consists of 16 blocks and not more than two of the blocks do not conform to any one of the requirements in 5.2 considered separately for the declared class, the sample and the corresponding production shall be accepted. If more than two of the blocks do not conform to any one of the requirements considered separately for the declared class, the sample and the corresponding production are not accepted and 6.3.7 applies.

B. Variables

When the standard deviation of a machine is known and regularly checked, the conformity of the production with 5.2 shall be assessed for each machine per day or consecutive production days not exceeding five (see sampling according to A.4.1.3). Each of the requirements in 5.2 shall be considered separately.

The conformity is assessed on a 10 % fractile.

The acceptability of the samples considered shall be checked using a control chart conforming to either ISO 7966 or ISO 7873 and taking into account 5.2, provided the probability of acceptance is equivalent to that resulting from assessment by attributes.

6.3.8.2 Weathering resistance (class 2 - water absorption)

The conformity of the production with 5.3.2 (class 2) shall be assessed for each family and for five production days, or more according to the switching rules (see sampling according to A.4.1.6).

a) If the sample consists of three or six blocks (see switching rules in A.5) and the requirements in 5.3.2 (class 2) are complied with, the sample and the corresponding production shall be accepted. If not, this sample shall be increased to nine blocks and the procedure given in b) shall apply.

b) If the sample consists of nine blocks and the requirements in 5.3.2 (class 2) are complied with, the sample and the corresponding production shall be accepted. If not, the sample and the corresponding production are not accepted and 6.3.7 applies.

6.3.8.3 Tensile splitting strength

A. Attributes

The conformity of the production with 5.3.3 shall be assessed for each machine per production day (see sampling according to A.4.1.4).

a) If the sample consists of eight blocks or fewer (see switching rules in A.5) and the strength *T* of each of the blocks is not lower than 3,6 MPa and the failing load not lower than 250 N/mm, the sample and the corresponding production shall be accepted. If not, this sample shall be increased to 16 blocks and the procedure given in b) shall apply.

b) If the sample consists of 16 blocks and the strength *T* of not more than one of the blocks is lower than 3,6 MPa but not lower than 2,9 MPa and no failing load is lower than 250 N/mm, the sample and the corresponding production shall be accepted. If not, the sample and the corresponding production are not accepted and 6.3.7 applies.

B. Variables

When the standard deviation for a machine is known and regularly checked, the conformity of the production with 5.3.3 shall be assessed for each machine per production day or consecutive production days not exceeding five (see sampling according to A.4).

The conformity is assessed on a 5 % fractile.

The acceptability of the samples considered shall be checked using a control chart complying either with ISO 7966 or ISO 7873 and taking into account 5.3.3, provided the probability of acceptance is equivalent to that resulting from testing by attributes (see annex K).

If the sample and the corresponding production are not accepted, 6.3.7 applies.

6.3.8.4 Visual aspects

The conformity of the production with 5.4 shall be assessed in case of doubt (see sampling according to A.4). The sample tested shall satisfy the requirements of the standard. If not, the sample and the corresponding production are not accepted and 6.3.7 applies.

7 Marking

The following particulars relating to blocks shall be supplied:

1	2	
*	*	Identification of the manufacturer or the factory
	*	Identification of the date of production and,
* or *		if delivered earlier than the date on which the blocks are declared suitable for use, the identification of this date
*	*	Identification of the class(es) where applicable (see below)

*	*	The number of this European Standard
*		Identification of the product.

1: On the delivery note or on the invoice or on the manufacturer's declaration.

2: On 0,5 % of the blocks with a minimum of one marking per package or on the packaging itself if not reused.

Classes and their identification:

Requirement	Marking
weathering resistance	A, B or D
abrasion resistance	F, H or I
Diagonals	J or K

Where ZA.3 covers the same information as this clause 7, the requirements of this clause are met for CE marked products.

8 Test report

The following particulars shall be supplied in the test report (other than for tests for factory production control):

1) the name of the organisation carrying out the test;

2) the name of the person carrying out the test;

3) the date of the test;

4) the name of the source providing the sample;

5) the sample reference including the date of production;

6) the name of the person taking the sample;

7) the relevant EN number and annex;

8) the name of the test;

9) the test result;

10) any pertinent remarks about the sample or test result.

Annex A
(informative)

Inspection schemes

A.1 Equipment inspection

Subject		Aim	Method	Frequency
A.1.1 Testing and measuring equipment				
All testing and measuring equipment		Correct functioning and accuracy	Where applicable calibrating against equipment which has been calibrated traceable to national standards and is used exclusively for this purpose except as indicated in the test method	On (re)installation, after major repair or once per year
A.1.2 Storage and production equipment				
1	Storage of materials	Absence of contamination	Visual inspection or other appropriate method	- On installation - Weekly
2	Weighing or volumetric batching equipment	Correct functioning	Visual inspection	Daily
3		Block manufacturer's declared accuracy	Calibrating against equipment which has been calibrated traceable to national standards and is used exclusively for this purpose	- On (re)installation - Weighing: once a year. Volumetric: twice a year - In case of doubt
4	Mixers	Wear and correct functioning	Visual inspection	Weekly
5	Moulds	Cleanliness and condition	Visual inspection	Daily

A.2 Materials inspection

Subject		Aim	Method	Frequency
A.2.1 All materials				
1	All materials	To ascertain that the consignment is as ordered and from the correct source	Inspection of delivery ticket and/or label on the package showing conformity with the order	Each delivery
A.2.2 Materials not submitted to an assessment of conformity before delivery[1)]				
1	Cement and other cementitious materials	Conformity with block manufacturer's requirements	Appropriate test method	Each delivery
2	Aggregates	Conformity with block manufacturer's requirements	Visual inspection	Each delivery
3		For example: - Particle grading - Impurities or contamination	 Test by sieve analysis Appropriate test method	- First delivery from new source - In case of doubt - Once per week - First delivery from new source - In case of doubt
4	Admixture	Conformity with normal appearance	Visual inspection	Each delivery
5		Density	Block manufacturer's method	
6	Additions/ pigments	Conformity with normal appearance	Visual inspection	Each delivery
7		Density	Block manufacturer's method	
8	Water not taken from a public distribution system	Conformity with block manufacturer's requirements	Testing according to standard	- First use of new source - Water from open water course: three times a year, or more (depending on local conditions) - Other sources : once a year - In case of doubt
9	Recycled water	Check for solid content and other contaminants	Visual	Weekly
10			Block manufacturer's method	In case of doubt

[1)] Materials not audited by the block manufacturer or by a third party acceptable to the block manufacturer.

A.3 Production process inspection

Subject		Aim	Method	Frequency
1	Mixture composition	Conformity with intended composition (weight or volumetric batched)	- Visual on weighing equipment - Checking against production process documents	Daily
2		Conformity with intended mixture values (only volumetric batched)	Fresh concrete analysis	Monthly
3	Fresh concrete	Correct mixing	Visual check	Daily for each mixer
4	Production	Conformity with documented factory procedures	Checking actions against factory procedures	Daily

A.4 Product inspection

Subject		Aim	Method	Frequency [1, 2, 3)]
A.4.1 Product testing				
1	Visual aspects	See 5.4	Visual check	Daily
2			Annex J	In case of doubt (sample of 20 blocks).
3	Shape and dimensions	See 5.2	Annex C	Eight blocks per machine per production day
4	Tensile splitting strength and breaking load	See 5.3.3	Annex F	Eight blocks per strength family per machine per production day
5	Thickness of facing layer	See 5.1	Annex C	Eight blocks per strength family per machine per production day
6	Weathering resistance (only class 2)	See 5.3.2	Annex E	Three blocks per surface family per five production days
A.4.2 Marking, storage, delivery				
1	Marking	Marking of product according to clause 7	Visual check	Daily
2	Storage	Segregation of non-conforming product	Visual check	Daily
3	Delivery	Correct delivery age, loading and loading documents	Visual check	Daily

[1)] Type testing according to 6.2 of this standard not included.

[2)] The switching rules apply (see A.5).

[3)] See 6.1.

A.5 Switching rules

A.5.1 Normal inspection
The rate of sampling should be in accordance with A.4.1.
A.5.2 Normal to reduced inspection
Reduced inspection corresponds to half the rate of normal inspection[1)]. It should be used when normal inspection is effective and the preceding 10 successive samples have been accepted. A supplementary reduced inspection is allowed if the same conditions as above are satisfied under reduced inspection. This supplementary reduced inspection should correspond to half the rate of the reduced inspection.
A.5.3 Reduced to normal inspection
When reduced inspection or supplementary reduced inspection is in effect, normal inspection should be reinstated if any of the following occurs: - a sample is not accepted; - the production becomes irregular or delayed; - other conditions warrant that normal inspection should be instituted.
A.5.4 Tightened inspection
Tightened inspection requires the number of blocks in the sample to be doubled. It should be used if during normal inspection two out of five successive samples fail.
A.5.5 Tightened to normal inspection
Tightened inspection should continue until five successive samples are accepted. Then normal inspection may be resumed.
A.5.6 Stopped production
If production remains on tightened inspection for ten successive samples the production line should be deemed to be out of control and stopped. The production system should be reviewed and any necessary changes made. Having corrected the production system, production should start again on tightened inspection.
[1)] If the number of blocks in the sample is even, the reduction should be performed by dividing the number of blocks by two. In the other cases, the rate of sampling should be reduced by two.

Annex B
(normative)

Procedure for acceptance testing of a consignment at delivery

B.1 General

The sampling procedure and conformity criteria for a consignment at delivery distinguishes two cases:

— Case I: The product has not been submitted to an assessment of conformity by a third party (see 6.1.1);

— Case II: The product has been submitted to an assessment of conformity by a third party.

If case II applies, acceptance testing is not necessary, except in case of dispute (see 6.1.2).

The test for visual aspects shall be carried out prior to the tests for the other properties. The test shall be performed by the purchaser and manufacturer jointly at a location agreed between them, normally the site or factory.

Tests, except for visual aspects, shall be carried out in a laboratory agreed by the purchaser and the manufacturer. They both shall be given a reasonable opportunity to witness the sampling and testing. The tests may be carried out with the manufacturer's reliably calibrated test equipment.

In case of dispute only the contentious property or properties shall be tested.

B.2 Sampling procedure

B.2.1 General

The required number of blocks shall be sampled from each batch of the consignment of blocks up to the following quantities according to the cases defined in B.1:

— Case I : 1 000 m^2 ;

— Case II: depending upon the circumstances of the case in dispute, up to 2 000 m^2.

However, a partial batch of the consignment shall be added to the previous full batch when the quantity of the partial batch is less than half of the quantities given above.

The blocks for testing shall be selected as being representative of the consignment and shall be evenly distributed through the consignment.

B.2.2 Number of units to be sampled

The number of blocks to be sampled from each batch shall be in accordance with Table B.1.

B.2.3 Sampling plan

Table B.1 — Sampling plan

Property	Requirement	Testing method	Case I	Case II [3]
Visual aspects	5.4	Annex J	8 [1]	4 (16) [1]
Thickness of facing layer	5.1	C.6	8	4 (16)
Shape and dimensions	5.2	Annex C [2]	8 [1]	4 (16) [1]
Tensile splitting strength and breaking load	5.3.3	Annex F	8	4 (16)
Abrasion resistance (only classes 3 and 4)	5.3.4	Annex G or H	3	3
Slip/skid resistance (only where tested)	5.3.5	Annex I	5 [1]	5 [1]
Weathering resistance				
- class 2	5.3.2	Annex E	3	3 (9)
- class 3	5.3.2	Annex D	3	3

[1] These blocks may be used for subsequent tests.

[2] C.6 only applies for blocks with a facing layer.

[3] The number between brackets is the number to be sampled to avoid secondary sampling from the batch if, on the basis of the conformity criteria (see B.3.2), additional blocks shall be tested to assess conformity.

B.3 Conformity criteria

B.3.1 Visual aspects

When required according to 5.4, the texture and colour of the sample shall show no significant difference to any reference sample supplied by the manufacturer and approved by the purchaser.

No block of the sample tested shall show cracking or flaking. Blocks with a facing layer shall not show delaminations.

B.3.2 Other properties

In case I, the conformity criteria for type testing of Table 7 apply.

In case II, the conformity criteria for attributes of 6.3.8 apply for the properties included. For the other properties, the conformity criteria of Table 7 apply.

Annex C
(normative)

Measurement of the dimensions of a single block

Alternative test methods, e.g. go and no-go gauges, may be used provided at least the same accuracy is achieved as in the following test method.

C.1 Preparation

Remove all flashings and burrs from the block to be measured.

C.2 Plan dimensions

C.2.1 Apparatus

Measuring equipment capable of measuring with an accuracy of 0,5 mm.

C.2.2 Procedure

Measure the relevant work dimensions in two different places for each dimension and record the actual dimensions obtained to the nearest whole number of millimetres.

For a rectangular block with a diagonal greater than 300 mm, measure the diagonals and record the difference between the two measurements.

C.3 Thickness

C.3.1 Apparatus

Measuring equipment capable of measuring with an accuracy of 0,5 mm.

C.3.2 Procedure

Measure the thickness of a block to the nearest millimetre. Take measurements at four points at opposite sides at a minimum of 20 mm from the edge of the block. Record the four measurements and calculate the mean thickness to the nearest millimetre. Calculate and record the maximum difference between any two readings to the nearest millimetre.

C.4 Flatness and bow

C.4.1 Apparatus

Measuring equipment capable of measuring with an accuracy of 0,1 mm over the specified length ± 1 mm.

NOTE For example, a notched straightedge and gauge, both made of steel, as shown in Figure C.1.

C.4.2 Procedure

The maximum convex and concave deviations shall be determined along the two diagonal axes of the upper face to the nearest 0,1 mm. Record both results.

C.5 Chamfer

C.5.1 Apparatus

Measuring equipment capable of measuring with an accuracy of 0,5 mm.

NOTE See example given in Figure C.2.

C.5.2 Procedure

Make a measurement at each side of a block, with a maximum of four measurements per block. Calculate and record the mean vertical and horizontal dimensions of the chamfer to a whole number of millimetres.

Check for conformity with the manufacturer's values.

C.6 Thickness of facing layer

C.6.1 Apparatus

Measuring equipment capable of measuring with an accuracy of 0,5 mm.

C.6.2 Procedure

Take a block which has been split.

Measure the thickness of the facing layer on the split face at the point where, by visual inspection, the value will be a minimum. Record the measurement to the nearest millimetre.

The thickness of the facing layer shall not be measured on the chamfer. Isolated particles of aggregate protruding into the surface layer shall be ignored.

C.7 Examples of measuring equipment

C.7.1 Metal rectangular box

A metal rectangular box large enough to enclose a block. The horizontal base plate and two adjoining vertical sides fixed. The two other vertical sides can be moved horizontally parallel to the fixed sides. The distance between the pairs of parallel sides can be read from a scale to a whole number of millimetres. The construction of the apparatus has to be such that the accuracy of measurements obtained to a whole number of millimetres can be justified.

C.7.2 Notched straight edge and gauge

Dimensions in millimetres

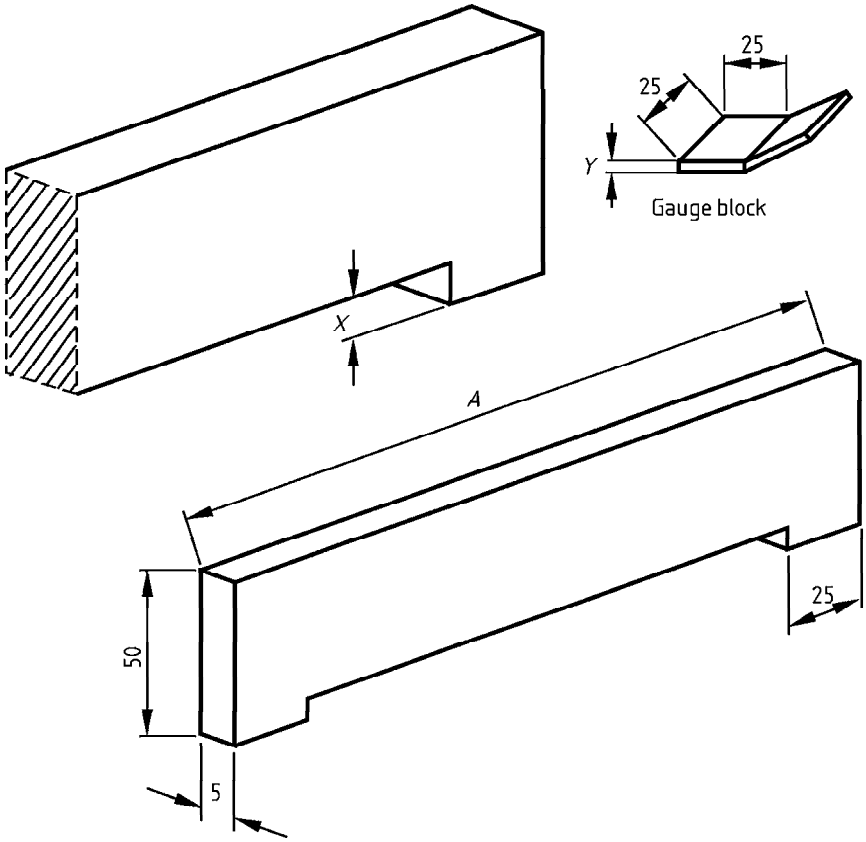


Figure C.1 — Example of notched straightedge and gauge

Table C.1 — Dimensions of a notched straightedge and gauge

Dimension *A*	Dimension *X*	Dimension *Y*
mm	mm	mm
300	1,5	2,5
400	2,0	3,5

C.7.3 A square graduated in millimetres on the inner edge

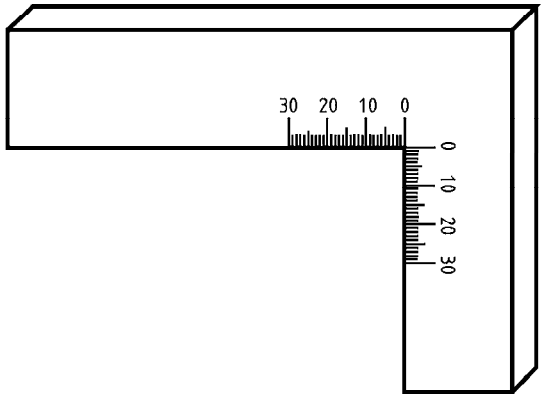


Figure C.2 — Example of a calibrated square

C.8 Test report

The test report shall include all the measurements taken.

See also clause 8.

Annex D
(normative)

Determination of freeze/thaw resistance with de-icing salt

D.1 Principle

The specimen is preconditioned and then subjected to 28 freeze thaw cycles while the surface is covered with a 3 % NaCl solution. The material that has scaled off is collected and weighed and the result expressed in kilograms per square metre.

D.2 Specimen

The specimen shall incorporate an upper face area greater than 7 500 mm^2 but less than 25 000 mm^2, which shall be the test surface and shall have a maximum thickness of 103 mm. If the specimen has to be taken from a block to meet this requirement it shall be taken when it is at least 20 days old.

D.3 Materials

D.3.1 ***Potable water***

D.3.2 ***Freezing medium***, consisting of 97 % by mass of potable water and 3 % by mass of NaCl.

D.3.3 ***Adhesive*** for gluing the rubber sheet to the concrete specimen. The adhesive shall be resistant to the environment in question.

NOTE Contact adhesive has proved to be suitable.

D.3.4 ***Silicon rubber*** or other sealant to provide a seal between the specimen and the rubber sheet and to fill in any chamfer around the perimeter of the specimen.

D.4 Apparatus

D.4.1 ***Diamond saw*** for cutting the concrete specimen.

D.4.2 ***Climate chamber*** with a temperature of (20 ± 2) °C and a relative humidity of (65 ± 10) %. In the climate chamber the evaporation from a free water surface shall be (200 ± 100) g/m^2 in (240 ± 5) min. The evaporation shall be measured from a bowl with a depth of approximately 40 mm and a cross-section area of (22 500 ± 2 500) mm^2. The bowl shall be filled up to (10 ± 1) mm from the brim.

D.4.3 ***Rubber sheet***, (3,0 ± 0,5) mm thick which shall be resistant to the salt solution used and sufficiently elastic down to a temperature of –20 °C.

D.4.4 ***Thermal insulation***, Polystyrene (20 ± 1) mm thick with a thermal conductivity between 0,035 W/(mK) and 0,04 W/(mK) or equivalent other insulation.

D.4.5 ***Polyethylene sheet,*** 0,1 mm to 0,2 mm thick.

D.4.6 ***Freezing chamber*** with time controlled refrigerating and heating system with a capacity and air circulation such that the time-temperature curve presented in Figure D.3 can be followed.

D.4.7 ***Thermocouples***, or an equivalent temperature measuring device, for measuring the temperature in the freezing medium on the test surface with an accuracy within ± 0,5 °C.

D.4.8 ***Vessel*** for collecting scaled material. The vessel shall be suitable for use up to 120 °C and shall withstand sodium chloride attack.

D.4.9 ***Paper filter*** for collecting scaled material.

D.4.10 ***Brush***, 20 mm to 30 mm wide paint brush with the bristles cut down to about 20 mm long for brushing off material that has scaled.

D.4.11 ***Spray bottle***, containing potable water for washing off scaled material and washing salt out of scaled material.

D.4.12 ***Drying cabinet***, capable of operating at a temperature of (105 ± 5) °C.

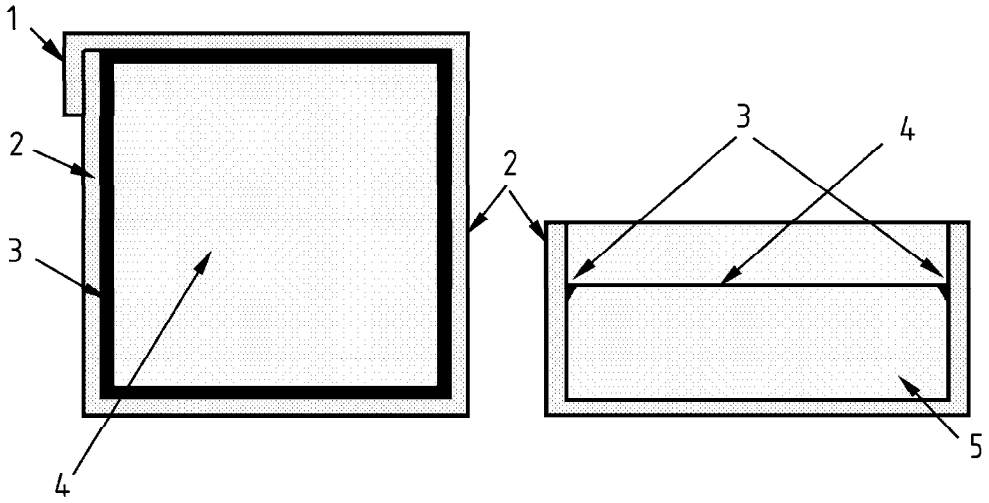
D.4.13 ***Balance***, with an accuracy within ± 0,05 g.

D.4.14 ***Vernier calipers***, with an accuracy within ± 0,1 mm.

D.5 Preparation of test specimens

When at least 28 and, except for receiving inspection, not more than 35 days old remove any flashings and loose material and then cure the samples for (168 ± 5) h in the climate chamber with a temperature of (20 ± 2) °C, relative humidity of (65 ± 10) % and an evaporation rate in the first (240 ± 5) min of (200 ± 100) g/m^2 measured in accordance with D.4.2. There shall be a minimum 50 mm air space between the samples. During this time the rubber sheet is glued to all surfaces of the specimen except the test surface and remains glued during the test. Use the silicon rubber or other sealant to fill in any chamfer around the perimeter of the specimen and to provide a seal around the test surface in the corner between the concrete and the rubber sheet to prevent water penetration between the specimen and rubber. The edge of the rubber sheet shall reach (20 ± 2) mm above the test surface.

NOTE The adhesive is normally spread on the concrete surfaces as well as on the rubber surfaces. The manner of gluing the rubber sheet illustrated in Figure D.1 has proved suitable.



Key

1 Overlap

2 Rubber sheet

3 Sealant string

4 Test surface

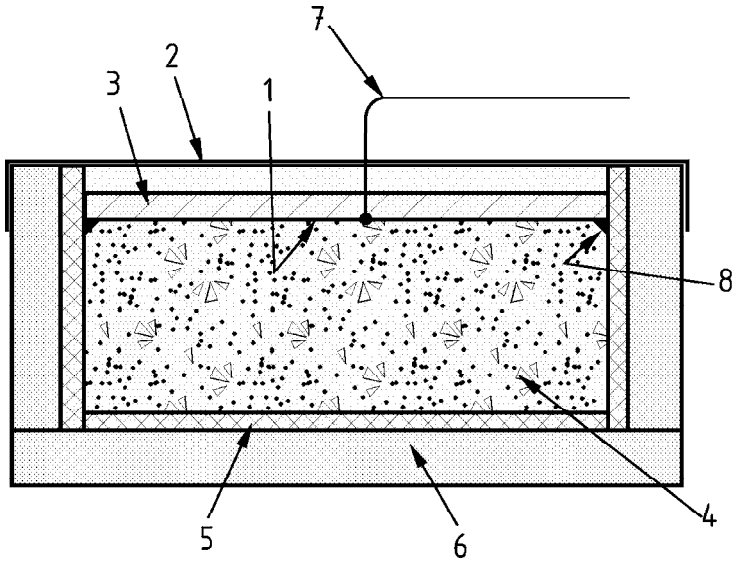
5 Specimen

Figure D.1 — An example of the cross-section of a specimen with the rubber sheet and a sealant string (right) and a specimen seen from above (left)

The tested area A shall be established from the mean of three measurements of its length and width to the nearest millimetre. After curing in the climate chamber, potable water with a temperature of (20 ± 2) °C shall be poured on the test surface to a depth of (5 ± 2) mm. This shall be maintained for (72 ± 2) h at (20 ± 2) °C and can be used to assess the effectiveness of the seal between the specimen and the rubber sheet.

Before the freeze/thaw cycling all surfaces of the specimen except the test surface shall be thermally insulated. This may be carried out during curing. The insulation shall be as described in D.4.4.

15 min to 30 min before the specimens are placed in the freezing chamber, the water on the test surface shall be replaced with a (5 ± 2) mm layer, measured from the top surface of the specimen, of 3 % NaCl in potable water. This shall be prevented from evaporating by applying a horizontal polyethylene sheet as shown in Figure D.2. The polyethylene sheet shall remain as flat as possible throughout the test and not come into contact with the freezing medium.



Key

1 Test surface

2 Polyethylene sheet

3 Freezing medium (salted water)

4 Specimen

5 Rubber sheet

6 Thermal insulation

7 Temperature measuring device

8 Sealant string

Figure D.2 — Principle of set-up used for the freeze/thaw test

D.6 Procedure

Place the specimens in the freezing chamber in such a way that the test surface does not deviate from a horizontal plane by more than 3 millimetres per metre in any direction and they are subjected to repeated freezing and thawing. During the test the time-temperature cycle in the freezing medium at the centre of the surface of all specimens shall fall within the shaded area in Figure D.3. Furthermore the temperature shall exceed 0 °C during each cycle for at least 7 h but not more than 9 h. Record the temperature continually in the freezing medium at the centre of the test surface for at least one specimen which shall be located in a representative position in the freezing chamber. Record the air temperature in the freezer during the test. Start the timing of the first cycle of the test on a specimen within (0 ± 30) min of it being placed in the freezing chamber. If a cycle has to be interrupted keep the specimen in the frozen state between – 16 °C and – 20 °C. If this interruption is for more than three days the test shall be abandoned.

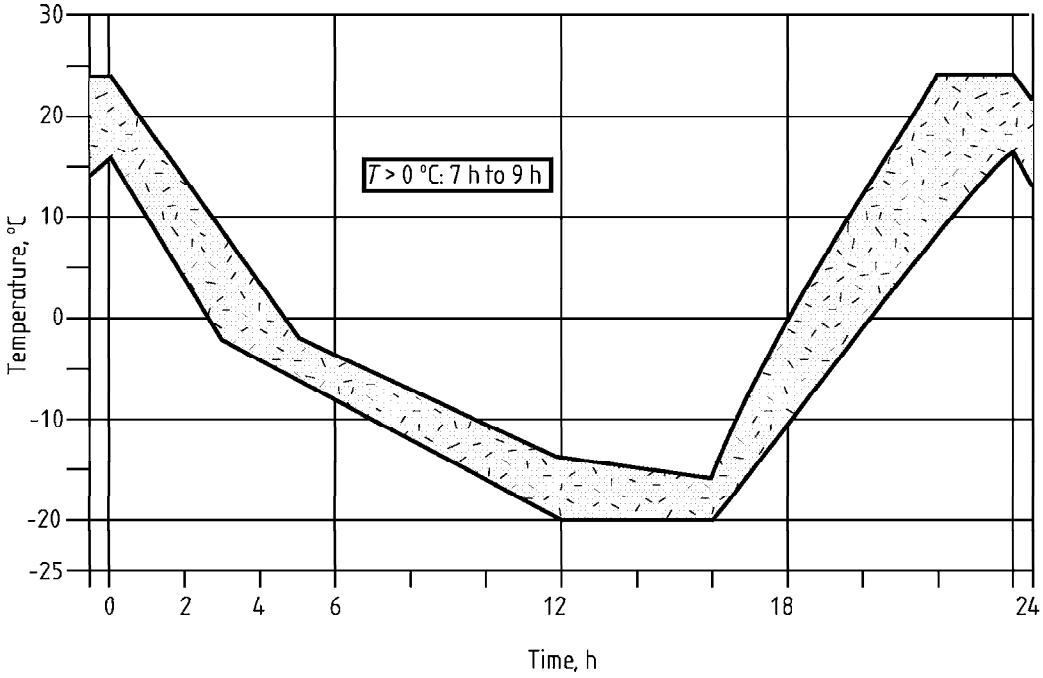


Figure D.3 — Time-temperature cycle

The break points specifying the shaded area are given in Table D.1.

Table D.1 — Co-ordinates of break points

Upper limit		Lower limit	
Time (h)	**Temp (°C)**	**Time (h)**	**Temp (°C)**
0	24	0	16
5	-2	3	-4
12	-14	12	-20
16	-16	16	-20
18	0	20	0
22	24	24	16

To obtain the correct temperature cycle for all the specimens ensure good air circulation in the freezing chamber. If only a few specimens are to be tested, fill the empty places in the freezer with dummies, unless it has been shown that the correct temperature cycle is achieved without them.

After 7 cycles and 14 cycles, during the thaw period add further 3 % NaCl in potable water if necessary in order to keep a (5 ± 2) mm layer on the surface of the samples.

After 28 cycles the following procedure shall be carried out for each specimen:

a) Collect material which has been scaled from the test surface by rinsing into the vessel using the spray bottle and brushing into the vessel until no further scaled material is removed;

b) Pour the liquid and scaled material in the vessel carefully through a filter paper. Wash the material collected in the filter paper with a minimum of 1 l of potable water to remove any remaining NaCl. Dry the filter paper and collected material for at least 24 h at (105 ± 5) °C. Determine to ± 0,2 g the dry mass of the scaled material, making due allowance for the filter paper.

D.7 Calculation of test results

Calculate the mass loss per unit area of the specimen (L) in kilograms per square metre from the equation :

$$L = \frac{M}{A}$$

where

M is the mass of the total quantity of material scaled after 28 cycles, in kilograms;

A is the area of the test surface in square metres.

D.8 Test report

The test report shall include the following information:

a) the mass loss per unit area of the specimen (L) in kilogram per square metre;

b) the mass of total quantity of material scaled after 28 cycles in milligrams;

c) the area of the test surface in square millimetres.

See also clause 8.

Annex E
(normative)

Determination of total water absorption

E.1 Principle

After conditioning the specimen to (20 ± 5) °C it is soaked to constant mass and then oven dried to constant mass. The loss in mass is expressed as a percentage of the mass of the dry specimen.

E.2 Specimen

If a block weighs more than 5,0 kg it shall be cut through its full height to provide a specimen not greater than 5,0 kg.

E.3 Materials

Potable water.

E.4 Apparatus

E.4.1 ***Ventilated drying oven*** with a capacity in litres to an area of ventilation channels in square millimetres less than 2 000 in which the temperature may be controlled to (105 ± 5) °C. It shall have a volume at least 2½ times greater than the volume of specimens to be dried at any one time.

E.4.2 ***Flat based vessel*** having a capacity at least 2½ times the volume of the samples to be soaked and a depth at least 50 mm greater than the height of the specimens in the attitude that they will be soaked.

E.4.3 ***Balance*** reading in grams and accurate to 0,1 % of the reading.

E.4.4 ***Stiff brush***.

E.4.5 ***Cloth***.

E.5 Preparation of the test specimens

Remove all dust, flashing, etc. with a brush and ensure that each specimen is at a temperature of (20 ± 5) °C.

E.6 Procedure

Immerse the specimens in potable water at a temperature of (20 ± 5) °C using the vessel until constant mass M_1 is reached. Separate the specimens from each other by at least 15 mm and ensure a minimum of 20 mm water above them. The minimum period of immersion shall be three days and constant mass shall be deemed to have been reached when two weighings performed at an interval of 24 h show a difference in mass of the specimen of less than 0,1 %. Before each weighing wipe the specimen with the cloth which has been moistened and squeezed to remove any excess of water. The drying is correct when the surface of the concrete is dull.

Place each specimen inside the oven in such a way that the distance between each specimen is at least 15 mm. Dry the specimen at a temperature of (105 ± 5) °C until it reaches constant mass M_2. The minimum period of drying shall be three days and constant mass shall be deemed to have been reached when two weighings performed at an interval of 24 h show a difference in mass of the specimen of less than 0,1 %. Allow the specimens to cool to room temperature before they are weighed.

E.7 Calculation of test results

Calculate the water absorption W_a of each specimen as a percentage of its mass from the equation:

$$W_a = \frac{M_1 - M_2}{M_2} \times 100\ \%$$

where

M_1 is the initial mass of the specimen (g);

M_2 is the final mass of the specimen (g).

Calculate the water absorption of the sample as the mean of the water absorption values of the specimens.

E.8 Test report

The test report shall give the value of water absorption for each of the specimens.

See also clause 8.

Annex F
(normative)

Measurement of strength

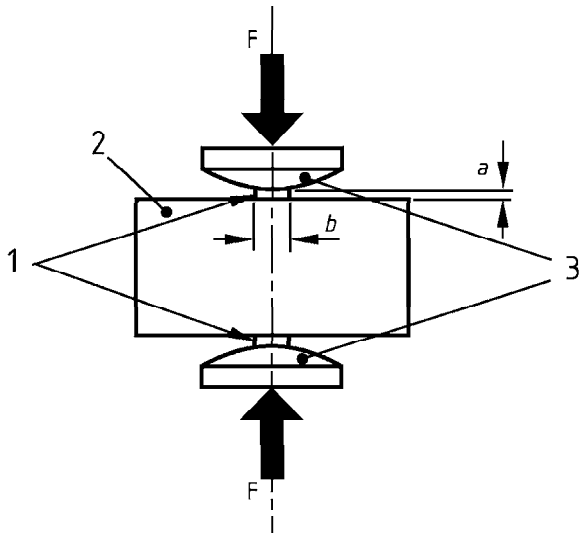
F.1 Apparatus

The testing machine shall have a scale with an accuracy of ± 3 % over the range of the anticipated test loads and be capable of increasing the load at specified rates.

The testing machine shall be equipped with a device composed of two rigid bearers (see Figure F.1) whose contact surface has a radius of (75 ± 5) mm.

The two bearers shall be held in the same vertical plane with a tolerance of ± 1 mm at the bearers end. The upper bearer shall be able to rotate in its transverse axis.

The two packing pieces shall be (15 ± 1) mm wide (b), (4 ± 1) mm thick (a) and at least 10 mm longer than the anticipated fracture plane.



Key

1 Packing pieces

2 Paving block

3 Rigid bearers

Figure F.1 — Principle of testing

The packing pieces shall be made of a material that meets the following hardness criterion:

When submitted to a punching test by means of a rod of circular cross section, having a diameter of (16,0 ± 0,5) mm and applying a force at a rate of (48 ± 10) kN/min, the instantaneous penetration when the force of (20 ± 5) kN is achieved shall be equal to (1,2 ± 0,4) mm.

F.2 Preparation

Use whole blocks and remove any burrs, high spots, etc. If a face is rough, textured or curved it shall be prepared by grinding or capping. The least amount of material shall be removed to produce a flat face.

Immerse the blocks in water at (20 ± 5) °C for (24 ± 3) h, remove, wipe dry and test immediately.

Other methods of preparation can be used for routine testing providing there is a correlation between the results of the two methods, e.g. using ungrounded rough textured or curved blocks instead of ground blocks.

F.3 Procedure

Place the block in the testing machine with the packing pieces on the upper face and the bed face in contact with the bearers. Ensure that the packing pieces and the axes of the bearers are in line with the splitting section of the block.

The splitting section(s) shall be chosen according to the following order of priority.

a) The test is carried out along the longest splitting section of the block, parallel and symmetrical to the edges, thus permitting that the following condition is satisfied:

   — The distance of the splitting section to any side face is at least 0,5 times the block thickness over at least 75 % of the splitting section area.

b) If the above mentioned condition cannot be met, the test is carried out along two splitting sections chosen in a way that the following condition is satisfied:

   — The distance of one splitting section to the other splitting section or to any side face of the block is at least 0,5 times the block thickness over at least 75 % of the splitting section length considered.

c) If neither of the above mentioned conditions can be met, the splitting section shall be chosen in such a way that the greatest total proportional section length satisfying the distance requirement is obtained.

d) If the block section is square, hexagonal or circular in plan, the splitting section shall be chosen so that it is the shortest length passing through the centre of the plan area.

Apply the load smoothly and progressively at a rate which corresponds to an increase in stress of (0,05 ± 0,01) MPa/s. Record the failure load.

Calculate the area of the failure plane(s) of the block tested from the equation:

$$S = l \times t$$

where

S is the area of the failure, in square millimetres;

l is the mean of two measurements of the failure length, one at the top and one at the bottom of the block, in millimetres;

t is the thickness of the block at the failure plane in millimetres and is the mean of three measurements; one in the middle and one at either end.

F.4 Calculation of test results

If testing is performed along two transverse test sections of the same block, the splitting strength of the block is considered the mean of the two individual results.

Calculate the strength T in megapascal of the block tested from the equation:

$$T = 0{,}637 \times k \times \frac{P}{S}$$

where

T is the strength, in megapascals;

P is the failure load, in newtons;

k is a correction factor for the block thickness calculated by the equation:

$k = 1{,}3 - 30\,(0{,}18 - t/1\,000)^2$ if $140\ \text{mm} < t \leq 180\ \text{mm}$

or:

$k = 1{,}3$ if $t > 180\ \text{mm}$

or:

for $t \leq 140$ mm determined from Table F.1.

Table F.1 — Correction factor k

t (mm)	40	50	60	70	80	90	100	110	120	130	140
k	0,71	0,79	0,87	0,94	1,00	1,06	1,11	1,15	1,19	1,23	1,25

Calculate the failure load per unit length (F) in newtons per millimetre from the equation:

$$F = \frac{P}{l}$$

F.5 Test report

The test report shall include the following information:

a) *T*, the strength of the block to the nearest 0,1 MPa;

b) *F*, the failure load per unit length of the block to the nearest 10 N/mm of splitting length.

See also clause 8.

Annex G
(normative)

Measurement of abrasion resistance

G.1 Principle of wide wheel abrasion test

The test is carried out by abrading the upper face of a paving block with an abrasive material under standard conditions.

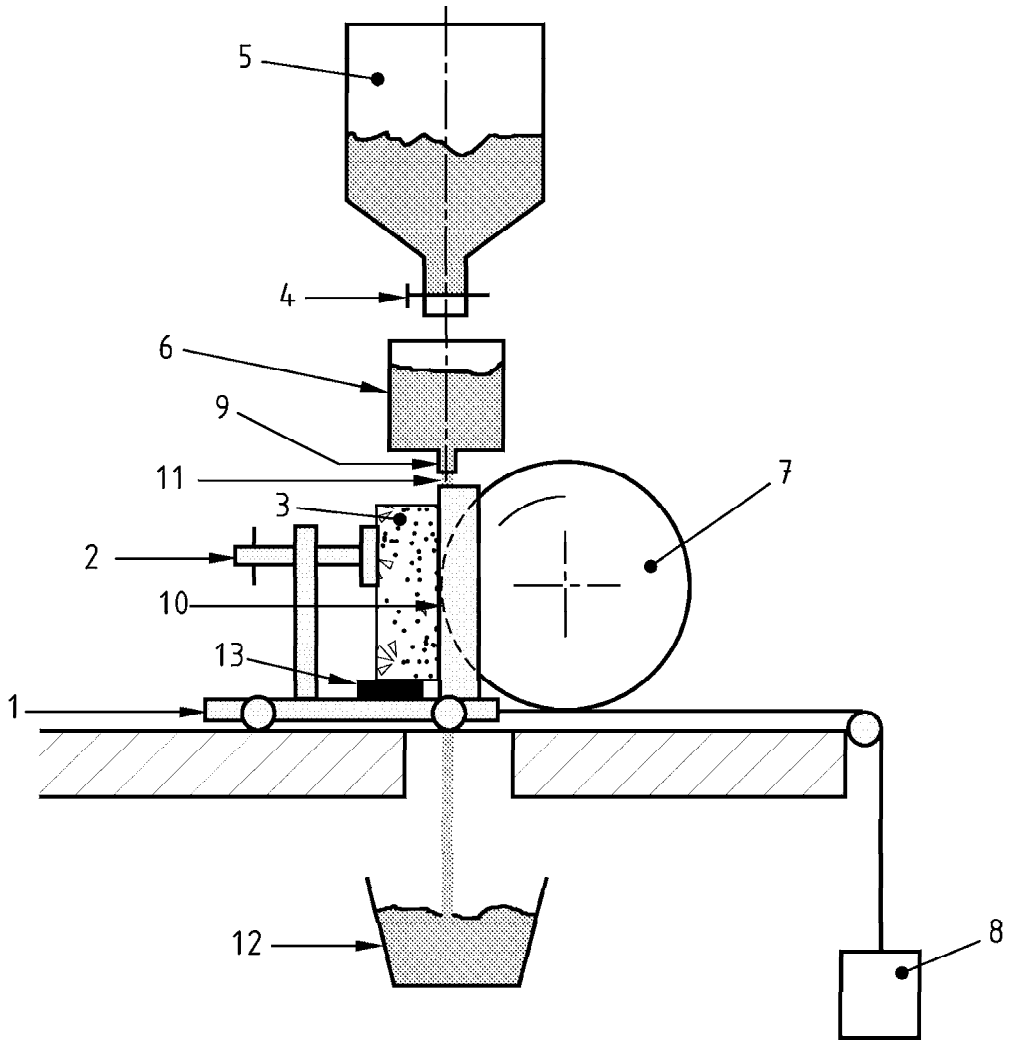
G.2 Abrasive material

The abrasive required for this test consists of a material comprising fused alumina (corundum) with a grit size of F80 in accordance with ISO 8486-1. It shall not be used more than three times.

G.3 Apparatus

The wearing machine (see Figure G.1) is essentially made of a wide abrasion wheel, a storage hopper with one or two control valves to regulate the output of the abrasive material, a flow guidance hopper, a clamping trolley and a counterweight.

When two valves are used, one shall be used to regulate the rate of flow and can be permanently set while the other is used to turn the flow on and off.



Key

1 Clamping trolley	6 Flow guidance hopper	11 Abrasive material flow
2 Fixing screw	7 Wide abrasion wheel	12 Abrasive collector
3 Specimen	8 Counterweight	13 Wedge
4 Control valve	9 Slot	
5 Storage hopper	10 Groove	

Figure G.1 — Principle of wearing machine

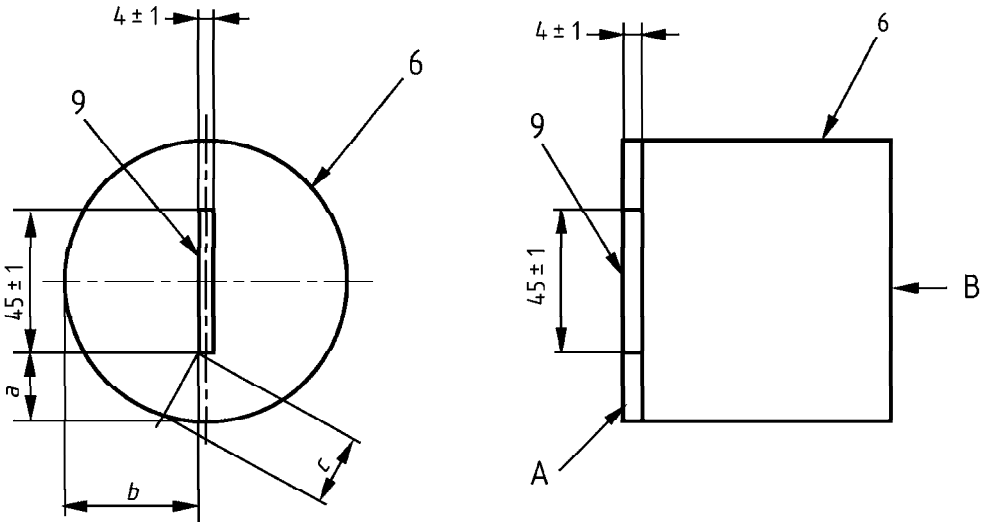
The wide abrasion wheel shall be made of a steel conforming to EN 10083-2 and with a Brinnel hardness of between 203HB and 245HB (as defined in EN ISO 6506-1, EN ISO 6506-2 and EN ISO 6506-3). Its diameter shall be (200 ± 1) mm and its width shall be (70 ± 1) mm. It shall be driven to rotate 75 revolutions in (60 ± 3) s.

A mobile **clamping trolley** is mounted on bearings and forced to move forwards to the wheel by a counterweight.

The **storage hopper** containing the abrasive material feeds a flow guidance hopper.

The **flow guidance hopper** may be cylindrical and shall have a slotted outlet. The length of the slot shall be (45 ± 1) mm and width shall be (4 ± 1) mm. The body of the flow guidance hopper shall be at least 10 mm bigger than the slot in all directions. In the case of a rectangular hopper with at least one of the sides inclined down to the length of the slot, these dimensional limitations are not necessary (see Figure G.2, example 2).

Dimensions in millimetres



a,b,c > 10

Key

A Vertical side

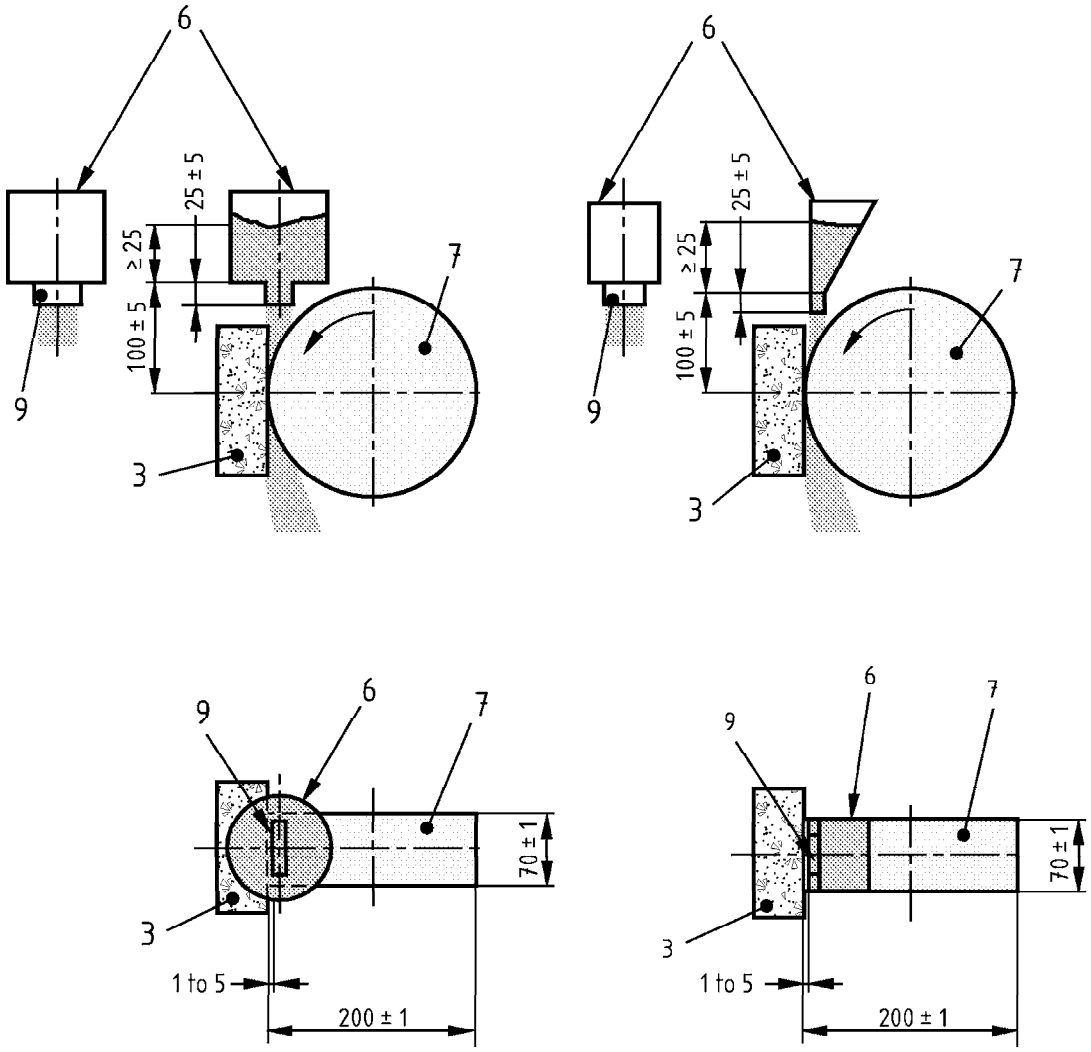
B Inclined side

See Figure G.1

Figure G.2 — Position of slot in the base of the flow guidance hopper

The distance of the fall between the slot and the axle of the wide abrasion wheel shall be (100 ± 5) mm and the flow of the abrasive shall be 1 mm to 5 mm behind the leading edge of the wheel (see Figure G.3).

Dimensions in millimetres



Key

See Figure G.1

Figure G.3 — Position of slot relative to wide abrasion wheel

The flow of the abrasive material from the flow guidance hopper shall be at least at a minimum rate of 2,5 l/min onto the wide abrasion wheel. The flow of abrasive shall be constant and the minimum level of the abrasive in the flow guidance hopper shall be 25 mm (see Figure G.3).

Useful tools for measuring the results are:

a magnifying glass preferably equipped with a light, a steel ruler and a digital calliper.

G.4 Calibration

The apparatus shall be calibrated after grinding 400 grooves or every two months whichever is the lesser and every time there is a new operator, a new batch of abrasive, or a new abrasion wheel.

The abrasive flow rate shall be verified by pouring the material from a height of approximately 100 mm into a pre-weighed rigid container with a smooth rim, of height (90 ± 10) mm and of known volume when filled to the top, this shall be approximately 1 l. As the container fills, the pourer shall be raised to maintain approximately the 100 mm fall. When the container is filled, the top shall be struck off level and weighed to determine the mass of abrasive for a known volume i.e. the density. Abrasive shall be run through the wearing machine for (60 ± 1) s and collected below the abrasion wheel in a pre-weighed container of at least 3 l capacity. The filled container shall be weighed and from the density determined above, the rate of abrasive flow can be verified as more than or equal to 2,5 l/min.

The apparatus shall be calibrated against a reference sample of 'Boulonnais Marble' using the procedure in G.6 and the counterweight adjusted so that after 75 revolutions of the wheel in (60 ± 3) s the length of the groove produced is (20,0 ± 0,5) mm. The counterweight shall be increased or decreased to increase or decrease the groove length respectively. The clamping trolley/counterweight assembly shall be checked for undue friction.

The groove shall be measured using the procedure in G.7 to the nearest 0,1 mm and the three results averaged to give the calibration value.

An alternative material may be used for the reference sample if a good correlation is established with a reference sample of 'Boulonnais Marble.

The Boulonnais Marble reference is:

> Lunel demi-clair, thickness: ≥ 50 mm, “contre-passe 2 faces”, ground with a diamond grit size 100/120, roughness: Ra = (1,6 ± 0,4) µm, when measured with a rugotest calibrated in accordance with EN ISO 4288.

At every calibration of the apparatus the squareness of the sample supports shall be checked.

The groove on the reference sample shall be rectangular with a difference between the measured length of the groove at either side not exceeding 0,5 mm. If necessary check that:

— the sample has been held square to the wheel;

— the clamping trolley and the slot from the flow guidance hopper are parallel to the wheel axle;

— the flow of abrasive is even across the slot;

— the friction in the trolley/counterweight assembly is not undue.

G.5 Preparation of the specimen

The test specimen shall be a whole product or a cut piece measuring at least (100 × 70) mm incorporating the upper face of the unit.

The test piece shall be clean and dry.

The upper face, which shall be tested, shall be flat within a tolerance of ± 1 mm measured in accordance with C.4 in two perpendicular directions, but over 100 mm.

If the upper face has a rough texture or is outside this tolerance it shall be lightly ground to produce a smooth flat surface within tolerance.

Immediately before testing, the surface to be tested shall be cleaned with a stiff brush and covered with a surface dye to facilitate measuring the groove (e.g. painting with a marker pen).

G.6 Procedure

Fill the storage hopper with dry abrasive material, moisture content not exceeding 1,0 %. Move the clamping trolley away from the wide abrasion wheel. Position the specimen on it so that the groove produced shall be at least 15 mm from any edge of the specimen and fix the specimen on a wedge to let the abrasive flow pass under it. Place the abrasive collector beneath the wide abrasion wheel.

Bring the specimen into contact with the wide abrasion wheel, open the control valve and simultaneously start the motor so that the wide abrasion wheel achieves 75 revolutions in (60 ± 3) s. Visually check the regularity of the flow of the abrasive material during the test. After 75 revolutions of the wheel, stop the abrasive flow and the wheel. Whenever possible two tests shall be performed on each specimen.

G.7 Measuring the groove

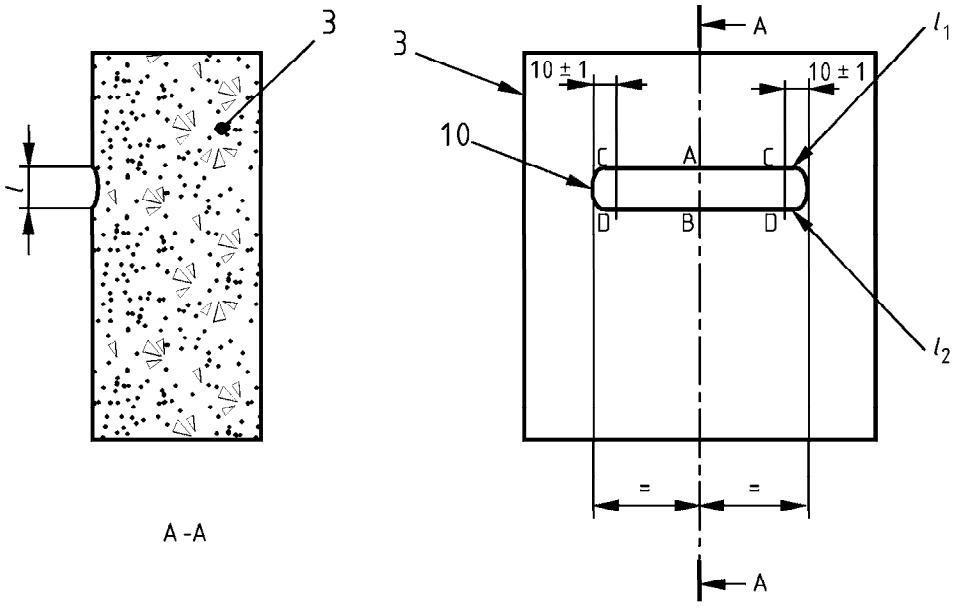
Place the specimen under a big magnifying glass nominally at least 2 times magnification and preferably equipped with a light to facilitate the measuring of the groove.

Using a ruler and a pencil, with a lead diameter of 0,5 mm and hardness 6H or 7H, draw the external longitudinal limits (l1 and l2) of the groove (see Figure G.4).

Then draw a line (A B) in the middle of the groove perpendicular to the centreline of the groove. Position a digital caliper square tips on the points A and B to the inside edge of the longitudinal limits (l1 and l2) of the groove and measure and record the dimension to the nearest 0,1 mm.

For calibration purposes, repeat the measurement (10 ± 1) mm from the ends of the groove (C D) to give three readings.

Dimensions in millimetres



Key

See Figure G.1

Figure G.4 — Example of a tested specimen showing a groove

Some surface dyes may be removed above the groove by action of the abrasive. This shall be ignored in producing line l1 which shall be drawn where the sample surface is abraded.

G.8 Calculation of test results

The result is the dimension corrected by a calibration factor and then rounded to the nearest 0,5 mm. The calibration factor is the arithmetic difference between 20,0 and the recorded calibration value.

If two grooves have been cut in a specimen the larger value shall be taken as the result.

NOTE For example, if the calibration value is 19,6 mm and the dimension is 22,5 mm, the result is 22,5 + (20,0 - 19,6) = 22,9 mm, rounded to 23,0 mm.

G.9 Test report

The test report shall include the lengths of the grooves.

See also clause 8.

Annex H
(normative)

Measuring of abrasion according to the Böhme test

H.1 Principle

Square sheets or cubes are placed on the Böhme disc abrader, on the test track of which standard abrasive is strewn, the disc being rotated and the specimens subjected to an abrasive load of (294 ± 3) N for a given number of cycles (see H.5).

The abrasive wear is determined as the loss in specimen volume.

H.2 Abrasive material

The standard abrasive used shall be fused alumina (artificial corundum)[3)] designed to produce an abrasive wear of 1,10 mm to 1,30 mm when testing standard granite specimens and of 4,20 mm to 5,10 mm when testing standard limestone specimens. Conformity with these requirements, the homogeneity of the material and the uniformity of bulk density and grading of the abrasive shall be checked.

H.3 Apparatus

H.3.1 ***Thickness measuring device***. To establish the reduction in thickness, a dial gauge, the plunger of which shall have a spherical bearing and an annular contact face of 8 mm outside and 5 mm inside diameter, and a measuring table, shall be used.

H.3.2 ***Disc abrader***. The Böhme disc abrader as shown in Figure H.1 consists essentially of a rotating disc with a defined test track to receive the abrasive, a specimen holder and a loading device.

H.3.3 ***Rotating disc***. The rotating disc shall have a diameter of approximately 750 mm and be flat and positioned horizontally. When loaded, its speed shall be (30 ± 1) revolutions per minute.

The disc shall be provided with a revolution counter and a device that switches off the disc automatically after 22 revolutions.

H.3.4 ***Test track***. The test track shall be annular, with an inside radius of 120 mm and an outside radius of 320 mm (i.e. be 200 mm wide), and be replaceable.

The track shall be made of cast iron with a perlitic structure, a phosphorus content not exceeding 0,35 % and a carbon content of more than 3 %. The track shall have a Brinell hardness of 190 to 220 HB 2,5/187,5 (as defined in EN ISO 6506-1, EN ISO 6506-2 and EN ISO 6506-3), determined as the mean from measurements taken at not less than ten points along the edge of the track.

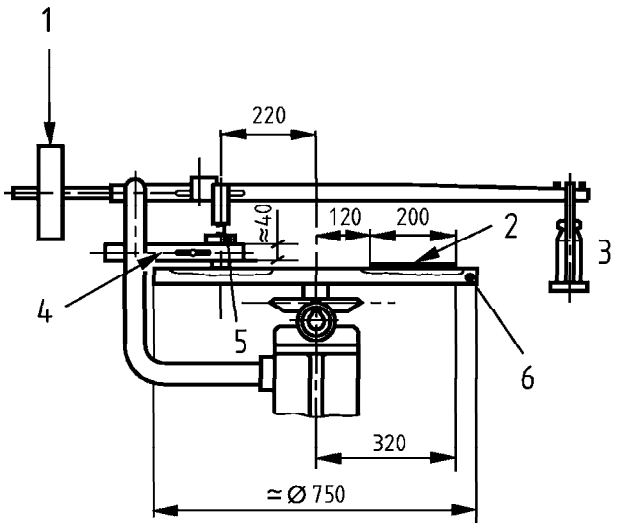
The track surface is subject to wear in service; the resulting reduction in thickness shall not exceed 0,3 mm and any grooves not deeper than 0,2 mm. If these values are exceeded, the track shall be replaced or refinished. When the track has been refinished three times, its hardness shall be determined anew.

[3)] Supply source and information can be obtained at: Materialprüfungsamt Nordhein-Westfalen, Marsbruchstraße 186, D-44287 Dortmund, Germany.

H.3.5 ***Specimen holder***. The specimen holder shall consist of a U-frame approximately 40 mm high, with a clear distance of (5 ± 1) mm from the test track. The frame shall be positioned so that the centreline distance between specimen and disc is 220 mm and the angle bead of the specimen holder, which supports the specimen, is located at a distance of (4 ± 1) mm above the disc. The mounting of the specimen holder shall ensure that, during testing, no vibration occurs.

H.3.6 ***Loading device***. The loading device shall consist of a lever of two arms of different length, a loading weight and a counterweight, the lever being pivoted with as little friction as possible and positioned almost horizontally during the test. The system shall be designed to ensure that the load is transferred vertically via the plunger to the centre of the specimen. The self-weight of the lever is balanced by the counter-weight and the scale to receive the loading weight. The force acting on the specimen results from the loading weight multiplied by the leverage ratio, the mass of the weight being selected to produce a test force of (294 ± 3) N (corresponding to about 0,06 N/mm²), which shall be verified by calculation.

Dimensions in millimetres



Key

1 Counterweight
2 Test track
3 Loading weight
4 Specimen holder
5 Specimen
6 Rotating disc

Figure H.1 — Principle of Böhme disc abrader

H.4 Preparation of specimens

Use square slabs or cubes with an edge length of (71,0 ± 1,5) mm as specimens.

The contact face and the opposite face of the specimen shall be parallel and flat. For determining the reduction in thickness as described in H.6, the opposite face shall, if appropriate, be ground parallel or otherwise machined so as to be parallel.

Generally the specimens shall be dried to constant mass at a temperature of (105 ± 5) °C, pregrinding of the contact face by four cycles (see H.5) being usually required.

For the exceptional case of testing specimens in the wet or water-saturated condition (see note to H.5), the specimens shall be immersed for not less than seven days and wiped with a damp artificial sponge prior to each weighing so that all specimens appear equally damp.

Each specimen shall be taken from no less than three different samples or workpieces of the same type.

Prior to testing, determine the density of the specimen, ρ_R, by measurements, to the nearest 0,1 mm, and by weighing, to the nearest 0,1 g.

In the case of two-layer specimens, determine the density for specimens taken separately from the wearing layer, such specimens also being ground prior to testing where necessary.

H.5 Procedure

Prior to the abrasion test and after every four cycles (see H.4), weigh the specimen to an accuracy of 0,1 g.

Pour 20 g of standard abrasive on the test track. Clamp the specimen into the holder and, with the test contact face facing the track, load centrally with (294 ± 3) N.

Start the disc taking care that the abrasive on the track remains evenly distributed over an area defined by the width of the specimen.

Test the specimen for 16 cycles, each consisting of 22 revolutions.

After each cycle, clean both disc and contact face, and turn the specimen progressively through 90° and pour new abrasive on the track as described in H.2.

When testing damp or water-saturated specimens, prior to each cycle, the track shall be wiped with a lightly damp artificial sponge and moistened before being strewn with abrasive. From the start of the test, water shall be caused to drip, at a rate of approximately 13 ml of water (corresponding to 180 drops to 200 drops) per minute onto the track from a container with an adjustable pivoting nozzle. The drops shall fall through a distance of approximately 100 mm on the middle of the track at a point 30 mm in front of the specimen. When testing in accordance with this method, care shall be taken to ensure that the abrasive is continuously returned to the effective area of the track (see H.3).

H.6 Calculation of test results

Calculate the abrasive wear after 16 cycles as the mean loss in specimen volume ΔV, from the equation:

$$\Delta V = \frac{\Delta m}{\rho_R}$$

where

ΔV is the loss in volume after 16 cycles in cubic millimetres;

Δm is the loss in mass after 16 cycles in grams;

ρ_R is the density of the specimen or, in the case of multi-layer specimens, the density of the wearing layer in grams per cubic millimetre.

H.7 Test report

Report the abrasive wear to the nearest whole number of 1 000 mm^3 per 5 000 mm^2.

See also clause 8.

Annex I
(normative)

Method for the determination of unpolished slip resistance value (USRV)

I.1 Principle

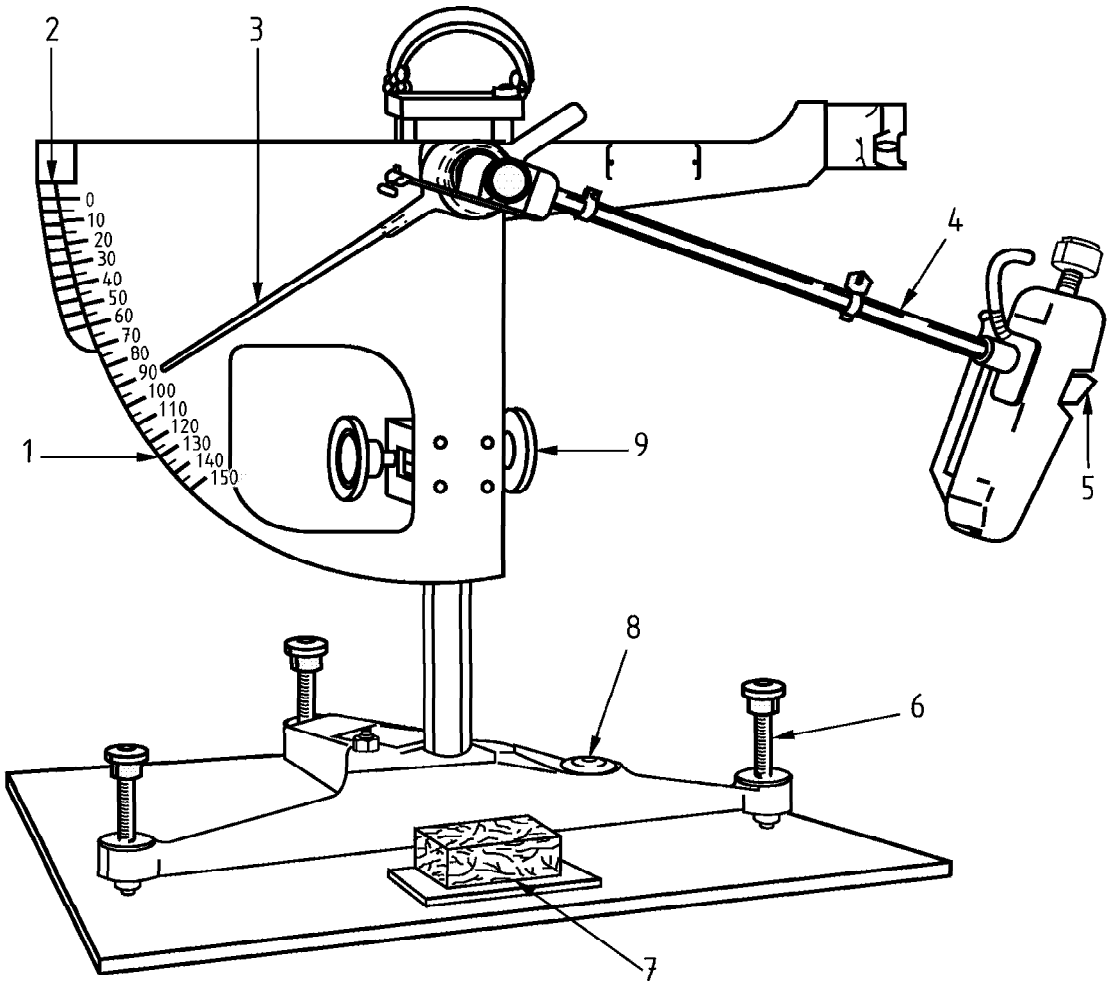
The measurement of USRV on the specimen is made using the pendulum friction test equipment to evaluate the frictional properties of the specimen on the upper face.

The pendulum friction test equipment incorporates a spring loaded slider made of a standard rubber attached to the end of the pendulum. On swinging the pendulum the frictional force between the slider and test surface is measured by the reduction in length of the swing using a calibrated scale.

I.2 Apparatus

I.2.1 Pendulum friction tester

I.2.1.1 The pendulum friction test equipment shall be manufactured as shown in Figure I.1. All bearings and working parts shall be enclosed as far as possible, and all materials used shall be treated to prevent corrosion under wet conditions.



Key

1 C scale (126 mm sliding length)
2 F scale (76 mm sliding length)
3 Pointer
4 Pendulum
5 Rubber slider
6 Levelling screw
7 Test specimen holder
8 Spirit level
9 Vertical adjustment screw

Figure I.1 — Pendulum friction test equipment

I.2.1.2 The pendulum friction test equipment shall have the following features:

1) a spring loaded rubber coated slider as specified in I.2.1.4 to I.2.1.10. It shall be mounted on the end of a pendulum arm so that the sliding edge is (510 ± 1) mm from the axis of suspension;

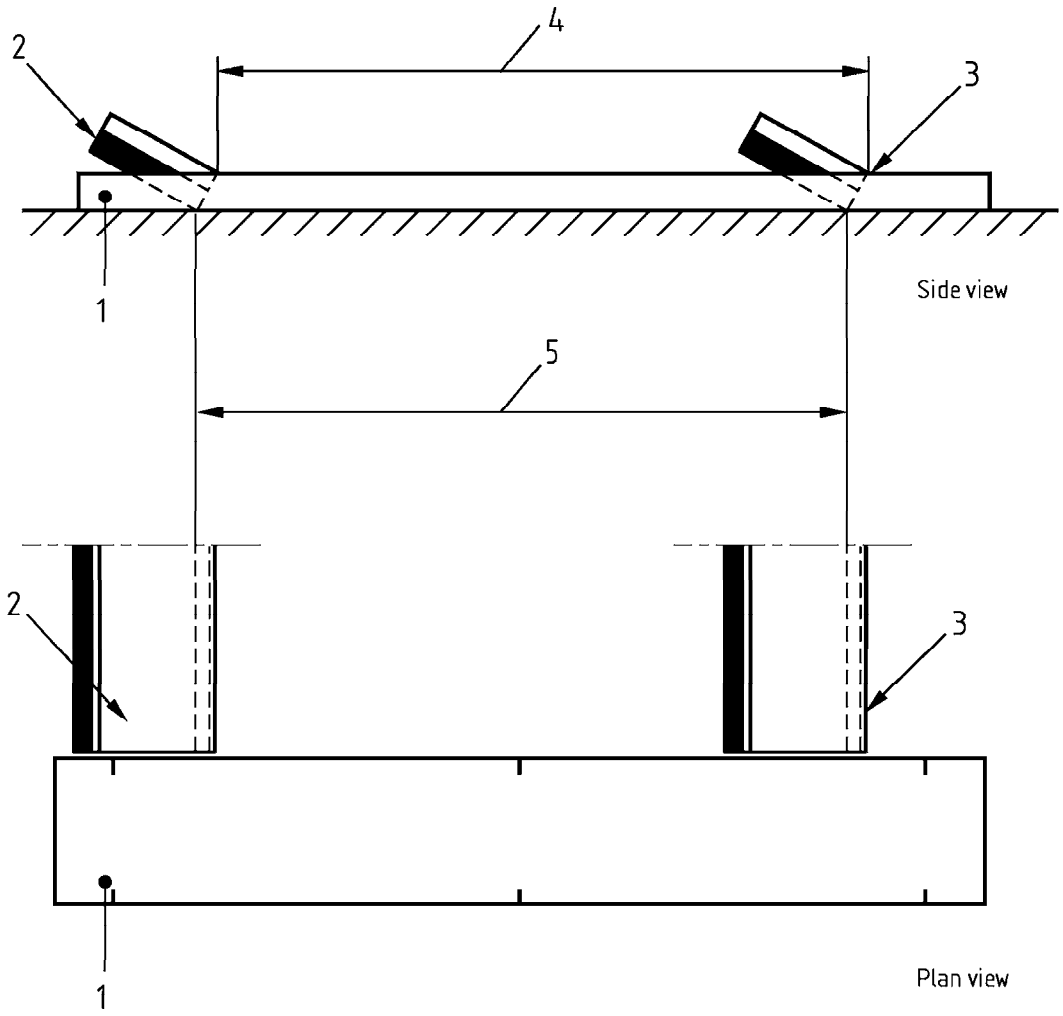
2) means of setting the support column of the equipment vertical;

3) a base of sufficient mass to ensure the equipment remains stable during the test;

4) Means of raising and lowering the axis of suspension of the pendulum arm so that the slider can:

— swing clear of the surface of the specimen; and

— be set to traverse a surface over a fixed length of (126 ± 1) mm. A gauge with this distance marked is required as shown in Figure I.2.



Key

1. Gauge
2. Slider
3. Reference edge
4. Sliding length measured
5. Actual sliding length

Figure I.2 — Sliding length gauge

5) means of holding and releasing the pendulum arm so that it falls freely from a horizontal position;

6) a pointer of nominal length 300 mm, balanced about the axis of suspension, indicating the position of the pendulum arm throughout its forward swing and moving over the circular scale. The mass of the pointer shall be not more than 85 g;

7) the friction in the pointer mechanism shall be adjustable so that, with the pendulum arm swinging freely from a horizontal position, the outward tip of the pointer may be brought to rest on the forward swing of the arm at a point (10 ± 1) mm below the horizontal. This is the 0 reading;

8) A circular C scale, calibrated for a sliding length of 126 mm on a flat surface, marked from 0 to 150 at intervals of five units.

I.2.1.3 The mass of the pendulum arm, including the slider, shall be (1,50 ± 0,03) kg. The centre of gravity shall be on the axis of the arm at a distance of (410 ± 5) mm from the axis of suspension.

I.2.1.4 The wide slider shall consist of a rubber pad (76,2 ± 0,5) mm wide; (25,4 ± 1,0) mm long (in the direction of swing) and (6,4 ± 0,5) mm thick, the combined mass of slider and base shall be (32 ± 5) g.

I.2.1.5 The slider shall be held on a rigid base with a centre pivoting axis which shall be mounted on the end of the pendulum arm in such a way that, when the arm is at the lowest point of its swing with the trailing edge of the slider in contact with the test surface, the plane of the slider is angled at (26 ± 3)° to the horizontal. In this configuration the slider can turn about its axis without obstruction to follow unevenness of the surface of the test specimen as the pendulum swings.

I.2.1.6 The slider shall be spring-loaded against the test surface. When calibrated, the static force on the slider as set by the equipment calibration procedure shall be (22,2 ± 0,5) N in its median position. The change in the static force on the slider shall be not greater than 0,2 N per millimetre deflection of the slider.

I.2.1.7 The initial resilience and hardness of the slider shall conform to Table I.1, and shall have a certificate of conformity including the name of the manufacturer and date of manufacture. A slider shall be discarded when the IRHD value measured in accordance with ISO 7619 fails to conform to the requirements of the table or not later than three years after manufacture.

Table I.1 — Properties of the slider rubber

	Temperature °C				
Property	0	10	20	30	40
Resilience (%)[1)]	43 to 49	58 to 65	66 to 73	71 to 77	74 to 79
Hardness (IRHD)[2)]	53 to 65				

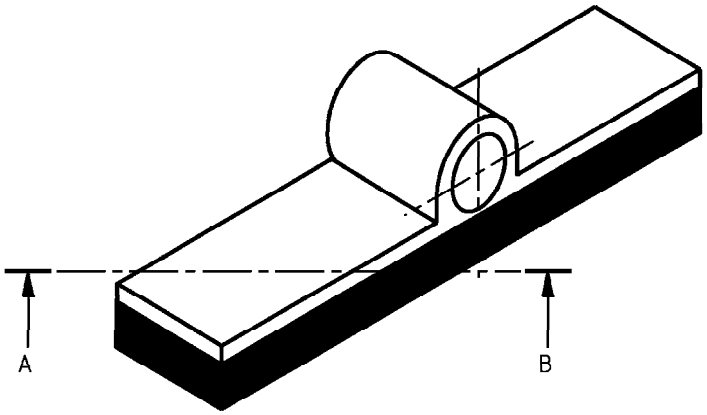
[1)] Rebound test in accordance with ISO 4662.

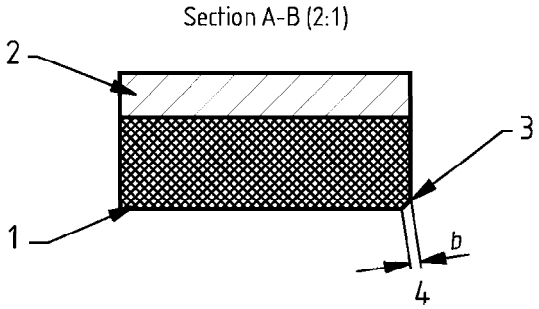
[2)] International Rubber Hardness Degrees in accordance with ISO 48.

I.2.1.8 The edges of the slider shall be square and clean-cut, and the rubber free from contamination by, for example, abrasive or oil. The slider shall be stored in the dark at a temperature in the range 5 °C to 20 °C.

I.2.1.9 Before using a new slider it shall be conditioned to produce a minimum width of striking edge of 1 mm as shown in Figure I.3.

This shall be achieved by setting up the tester and carrying out five swings on a dry surface with a friction value above 40 on the C scale followed by a further 20 swings on the same surface after wetting.





Key

1 Rubber slider

2 Aluminium backing

3 Striking edge

4 Worn width

Figure I.3 — Slider assembly illustrating the maximum wear or striking edge

I.2.1.10 The slider shall be discarded when the width of the striking edge as shown in Figure I.3 exceeds 3 mm or becomes excessively scored or burred. The slider can be reversed to expose a new edge, which will need to be conditioned.

I.2.2 A container with potable water at (20 ± 2) °C for wetting the surfaces of the test specimen and slider.

I.3 Calibration

The apparatus shall be recalibrated at least annually.

I.4 Sampling

Obtain a representative sample of five blocks of the same surface family.

Each block in the sample shall permit a test area of 136 mm × 86 mm which is representative of the whole block. This area shall be tested using the 76 mm wide slider over a nominal swept length of 126 mm, readings being taken on the C scale.

NOTE In the case of large blocks, representative samples should be cut from them for test.

I.5 Procedure

Keep the friction test equipment, and slider, in a room at a temperature of (20 ± 2) °C for at least 30 min before the test begins.

Immediately prior to testing with the friction tester, immerse the sample in water at (20 ± 2) °C for at least 30 min.

Place the friction tester upon a firm level surface and adjust the levelling screws so that the pendulum support column is vertical. Then raise the axis of suspension of the pendulum so that the arm swings freely, and adjust the friction in the pointer mechanism so that when the pendulum arm and pointer are released from the right-hand horizontal position the pointer comes to rest at the zero position on the test scale.

Before using a new slider, condition it using the method described in I.2.1.9.

Discard any slider that exceeds the requirements given in I.2.1.10.

Rigidly locate the test specimen with its longer dimension lying in the track of the pendulum, and centrally with respect to the rubber slider and to the axis of the suspension of the pendulum. Ensure that the track of the slider is parallel to the long axis of the specimen across the sliding distance.

Adjust the height of the pendulum arm so that in traversing the specimen the rubber slider is in contact with it over the whole width of the slider and over the specified swept length. Wet the surfaces of the specimen and the rubber slider with a copious supply of water, being careful not to disturb the slider from its set position. Release the pendulum and pointer from the horizontal position, catch the pendulum arm on its return swing. Record the position of the pointer on the scale (the pendulum test value). Perform this operation five times, rewetting the specimen each time, and record the mean of the last three readings. Relocate the specimen after rotating through 180° and repeat the procedure.

I.6 Calculation of test results

When the wide slider is used over a swept length of 126 mm, calculate the pendulum value of each specimen as the mean of the two recorded mean values measured in opposite directions to the nearest 1 unit on the C scale.

The USRV is the mean pendulum value obtained on the 5 specimens.

I.7 Test report

The test report shall include the following extra information:

1) the mean pendulum test value of each specimen;

2) the mean USRV of the sample.

See also clause 8.

Annex J
(normative)

Verification of visual aspects

J.1 Preparation

Lay out the samples at floor level in an interlocking pattern approximating to a square after examining each block for delamination.

J.2 Procedure

In natural daylight conditions an observer shall stand in turn at a distance of 2 m from each edge of the square and record any block showing cracks or flaking.

Compare the texture and the colour with the manufacturer's sample.

Annex K
(informative)

Example of the application of the method for checking conformity of tensile splitting strength by variables (6.3.8.3.B)

K.1 General

For factory production control by the manufacturer conformity may be determined either by attributes or by variables (see 6.3.8.3 B).

Based on the splitting test the flow-chart (see Figure K.1) shows the possible "routes": either by attributes or by variables; but it is always started by attributes because the variables route needs enough results to calculate the standard deviation.

The probability of acceptance is to be equivalent to that resulting form testing by "Attributes" (6.3.8.3 A).

K.2 Basic formula

The basic formula to check the conformity of a given production is:

$$\overline{X}_n \geq 3{,}6 + q_n \times s \text{ (MPa)}$$

$\overline{X}_n$ = the mean of the production sample of n products;

q_n = acceptance factor;

s = standard deviation for the production machine.

K.3 Acceptance factors

Depending on the number of samples the acceptance factors are:

n = 4	$q_4 = 0{,}9$
n = 8	$q_8 = 1{,}2$
n = 16	$q_{16} = 1{,}3$

K.4 Standard deviations *s*

Different methods should be used for the determination of the standard deviation s depending on the accuracy needed.

The minimum number of results to determine the standard deviation depends on the process stability: commonly 30 results are used, but if the stability is proved 15 may be enough. These results

(30 or 15) should be gathered from tests of a representative production period, e.g. 4 production days 8 or 4 results per day.

At regular intervals the standard deviation should be checked.

K.5 Application of switching rules

When the production is under control, the number of samples tested decreases.

That is logical, because the probability to produce defectives decreases. The switching rules are given in A.5.

K.6 Results

If the result of using the formula in K.2 is positive and no individual result T is below 2,9 MPa and no individual failure load F is below 250 N/mm, the corresponding production complies with the requirements of this standard. If the results do not meet the requirements, 6.3.7 applies.

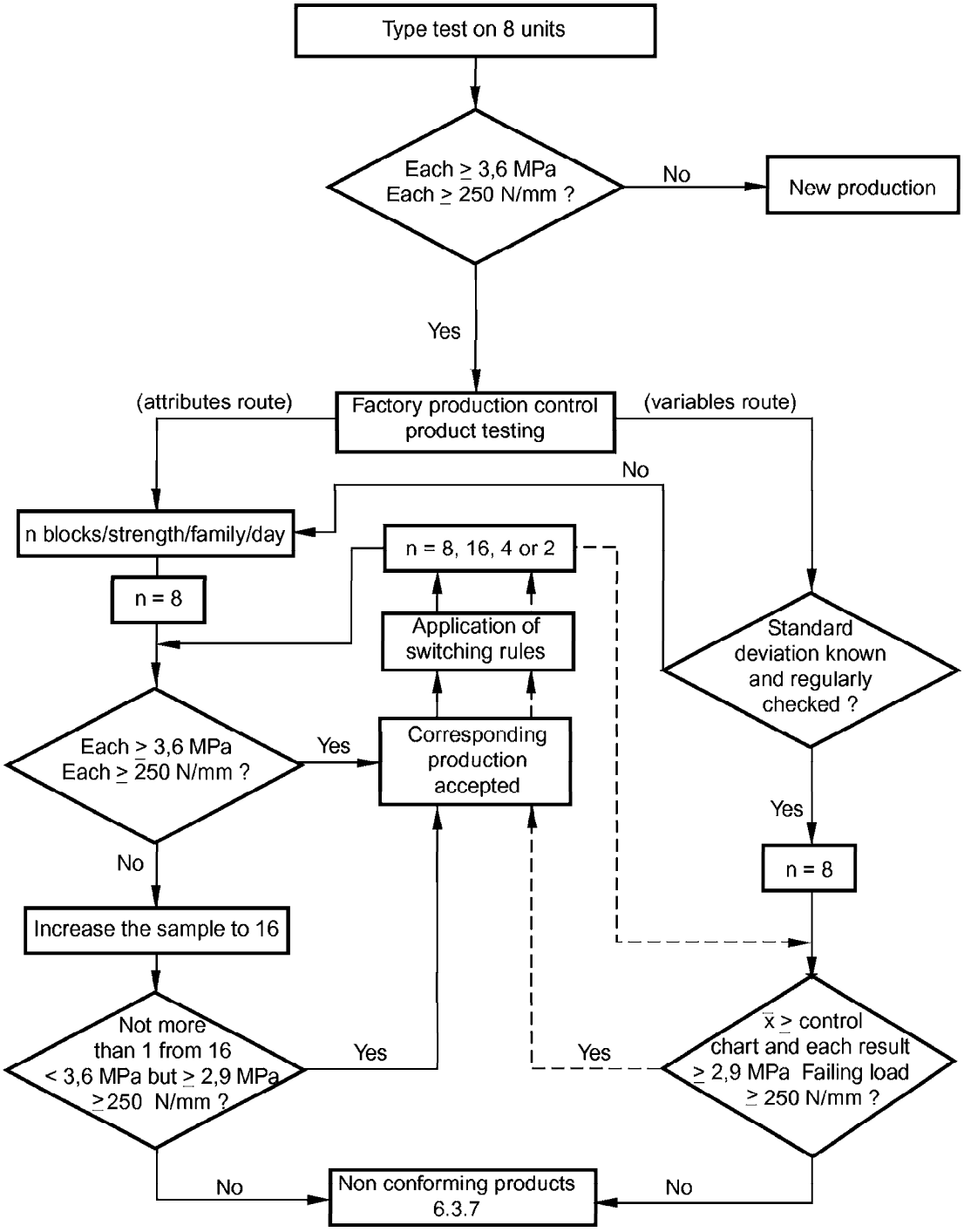


Figure K.1 — EN 1338 tensile splitting strength

Annex ZA
(informative)

Clauses of this European Standard addressing the provisions of the EU Construction Products Directive (89/106/EEC)

ZA.1 Scope and relevant characteristics

This European Standard and its annex ZA have been prepared under the Mandates M/119 'Floorings' and M/122 'Roof coverings, rooflights, roof windows and ancillary products', given to CEN by the European Commission and the European Free Trade Association.

The clauses of this European Standard shown in this annex meet the requirements of these Mandates given under the EU Construction Products Directive (89/106).

Compliance with this annex ZA confers a presumption of fitness of the construction products covered by this European Standard for their intended use under consideration in Table ZA.1, reference shall be made to the information accompanying the CE-marking

WARNING: Other requirements and EU directives, not affecting the fitness for intended use can be applicable to a construction product falling within the scope of this annex.

In addition to 4.2, there may be other requirements applicable to the products falling within the scope of this standard (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.

NOTE An informative database of European and national provisions on dangerous substances is available at the Construction website on EUROPA (CREATE, accessed through http://europa.eu.int).

Construction product:	Precast concrete paving blocks under the scope of this standard
Intended use(s):	Internal and external flooring and/or roof covering

Table ZA.1 — Required characteristics

Essential characteristics	Requirement clauses in this standard	Mandated levels or classes	Notes	Use
Reaction to fire	5.3.6.1	Class A1		Internal flooring
External fire performance	5.3.6.2	None	Deemed to satisfy	Roofing
Emission of asbestos	4.2	No content	see 4.2	Internal & external flooring and roofing
Breaking strength	5.3.3.1	None		Internal & external flooring
Slip/skid resistance	5.3.5.1	None	Satisfactory	Internal & external flooring
	5.3.5.2	None	Only for products where the whole upper surface is ground and/or polished to produce a very smooth surface	Internal & external flooring
Thermal conductivity	5.3.7	None		Internal flooring
Durability*	5.3.3.3	None		External flooring
	5.3.5.3	None		Internal & external flooring
* Where a member state wants to establish a relationship between durability and weathering resistance 5.3.2 applies				

The requirement for a certain essential characteristic is not applicable in those Member States (MS) where there are no regulatory requirements for that characteristic for the intended use of the product. In this case manufacturers placing their products on the market of these MSs are not obliged to determine, nor to declare, the performance of their products with regard to this characteristic and the option “No Performance Determined” (NPD) in the information accompanyingthe CE-marking (see ZA.3) may be used.

The NPD option may not be used for the essential characteristic of breaking strength.

ZA.2 Attestation of conformity

The system of attestation of conformity for the product indicated in Table ZA.1, in accordance with the Commission Decisions 97/808/EC and 98/436/EC, as amended, as given for this product family in annex III of the Mandates M/119 and M/122, is shown in Table ZA.2 for the indicated intended use:

Table ZA.2 — Attestation of conformity system

Product	Intended use	Level(s) or class(es)	Attestation of conformity system
Precast concrete paving blocks	For external uses and road finishes to cover external pedestrian and vehicular circulation areas	Asbestos: no content	4
Precast concrete paving blocks	For internal uses including enclosed public transport premises	Reaction to fire: A1* Asbestos: no content	4
Precast concrete paving blocks	For roofing	External fire performance deemed to satisfy ** Asbestos: no content	4
System 4: see CPD annex III.2. (ii) Third possibility * Materials of Class A1 that are not required to be tested for reaction to fire, according to Decision 1996/603/EC as amended. ** See Commission Decision 2000/553/EC.			

Table ZA.3 — Assignation of tasks

Tasks for the manufacturer	Scope of the tasks	Clauses to apply
Initial type testing	All relevant characteristics in Table ZA.1	6.2
Factory production control		6.3

ZA.2.2 Declaration of conformity

The manufacturer or his agent established in the EEA, shall prepare and retain a declaration of conformity, which entitles the manufacturer or his agent to affix the CE marking symbol. This declaration shall include:

— name and address of the manufacturer, or his authorised representative established in the EEA, and the place of production;

— description of the product (type, identification, use …), and a copy of the information accompanying the CE marking symbol;

— provisions to which the product conforms (e.g. annex ZA of this EN);

— particular conditions applicable to the use of the product (if necessary);

— name of, and position held by the person empowered to sign the declaration on behalf of the manufacturer or his agent.

The declaration shall be presented in the language(s) of the Member State of use of the product.

ZA.3 CE marking and labelling

The manufacturer or his authorised representative established within the EU or EFTA is responsible for the affixing of the CE marking symbol.

The CE marking symbol to affix shall be in accordance with Directive 93/68/EC and shall be accompanied by the following information. They shall appear on the packaging and/or on the accompanying commercial documents:

— the name or identifying mark of the producer;

— registered address of the producer;

— the last two digits of the year in which the marking was affixed;

— the number of this standard (EN 1338);

— the product type (i.e. Precast concrete block) and intended use(s), e.g.: internal flooring, external flooring and/or roofing; and

— information on the mandated characteristics/ values to declare.

For products intended for external pedestrian and vehicular circulation areas:

— breaking strength;

— slip/skid resistance;

— durability.

For products intended for internal flooring use:

— reaction to fire;

— breaking strength;

— slip/skid resistance;

— durability;

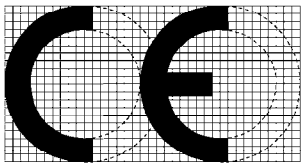
— thermal conductivity (where relevant).

For products intended for roof covering:

— external fire performance: deemed to satisfy.

Figures ZA.1 and ZA.2 give examples of products subject to strength durability and to weathering durability respectively, concerning the information to be given on the commercial documents or on the packaging.

Figure ZA.1 — Example of CE marking information

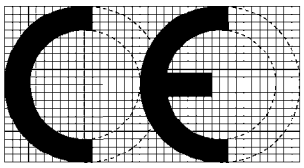


Anyco Ltd, P.O. Box 21, B 1050
2000

EN 1338
Precast concrete block

Intended Use:	**Internal flooring**	**External flooring**	**Roofing**
Emission of asbestos	Pass	X	X
Breaking strength	Pass	Pass	X
Slip/skid resistance	Satisfactory	Satisfactory	X
Thermal conductivity [W/(mK)]	1,2	X	X
External fire performance	X	X	Deemed to satisfy
Durability	Satisfactory	Satisfactory	X
Reaction to fire	A1	X	X
X = not relevant;			

Figure ZA.2 — Example of CE marking information



Anyco Ltd, P.O. Box 21, B 1050
2000

EN 1338
Precast concrete block (where the whole upper surface is ground and/or polished to produce a very smooth surface)

Intended Use:	**Internal flooring**	**External flooring**	**Roofing**
Emission of asbestos	Pass	X	X
Breaking strength	Pass	Pass	X
Slip/skid resistance	45	45	X
Thermal conductivity [W/(mK)]	1,2	X	X
External fire performance	X	X	Deemed to satisfy
Durability	Satisfactory	Satisfactory	X
Reaction to fire	A1	X	X
X =- not relevant			

National annex NA
(informative)

Tradition and practice in the use of concrete block paving in the UK

NA.1 Introduction

This national annex gives additional information and advice on the use of concrete paving blocks for users of this European Standard in the UK.

In addition, the following major differences exist between EN 1338 and BS 6717:2001.

— The limit on overall length and width in BS 6717 is not included in EN 1338.
— EN 1338 contains a tolerance on squareness for large blocks.
— EN 1338 does not give the option for a manufacturer to declare a loss of mass in the freeze/thaw test, but does include an alternative of establishing weathering resistance by water absorption.
— EN 1338 includes an extra class of abrasion resistance and an alternative test method, the Bohme test.
— EN 1338 does not contain a requirement for polished skid resistance (see **NA.7**) or classes for unpolished slip/skid resistance.
— EN 1338 contains clauses on fire performance and thermal conductivity.

NA.2 Shape and dimensions

EN 1338 does not limit the shape or the overall dimensions of concrete paving blocks, but does restrict the ratio of overall length to thickness to ≤4 (see **3.2**). Traditionally in the UK concrete paving units of (295 x 295) mm and under are referred to as "blocks" and units greater than this size are referred to as "flags".

NA.3 Designation

EN 1338 does not give any coded designations for the shapes or sizes of concrete paving blocks. In the UK a type "R" block will continue to be offered by manufacturers and will continue to signify a (200 x 100) mm rectangular block. The type "S" block, traditionally used to indicate a shaped block with a 2:1 format, will also continue to be used.

NOTE These are shape designations and are not to be confused with performance classes.

NA.4 Strength and use

The thickness of a block required for a particular use will depend upon the location and traffic in this location and an indication of these is given in the table below.

NOTE For a full design procedure reference should be made to BS 7533.

Table NA.1 — Typical block thickness for a range of applications

Up to 50 mm	**60 mm**	**80 mm**	**100 mm**
— Domestic drives, paths and patios	— Local authority footways — Car parks and lightly trafficked areas — Residential roads — Domestic drives	— Residential roads — Local authority footways — Higher speeds roads — Factory floors — Industrial pavements — Aircraft pavements	— Areas subjected to exceptional axle loads
NOTE The information in this table is taken from *Precast Concrete Paving: A Design Handbook*, Interpave: The Precast Concrete Paving and Kerb Association.			

NA.5 Weathering resistance

In areas subject to regular treatment with de-icing salts Class 3 should be used.

In areas subject to freeze/thaw without regular treatment with de-icing salts at least Class 2 products should be used.

In areas not subject to freeze/thaw at least Class 1 products should be used.

NOTE See **5.3.2.2**.

NA.6 Abrasion

In areas subject to very heavy pedestrian and vehicular traffic Class 4 products should be used.

In areas subject to normal pedestrian and vehicle use, e.g. public pavements and roads, etc. at least Class 3 products should be used.

In areas subject to light pedestrian and vehicular use e.g. gardens, drives, etc. at least Class 1 products should be used.

NOTE See **5.3.4.2**.

NA.7 Slip/skid resistance

If the manufacturer declares a slip/skid resistance value, the following slip resistance table gives an indication of the value against the potential for slip.

Table NA.2 —Pendulum test values

Pendulum test value	Potential for slip
Below 19	High
20 to 39	Moderate
40 to 74	Low
Above 75	Extremely low
NOTE The information in this table is taken from *The measurement of floor slip resistance. Guidelines recommended by the UK Slip Resistance Group, Issue 2*, RAPRA, 2000.	

NOTE For additional information on skid resistance, reference should be made to BS 7976.

NA.8 Tactility

NOTE For information on tactility, reference should be made to BS 7997[1)].

NA.9 CE marking

It is not mandatory to CE mark a product in order to meet the requirements of EN 1338 or to put a product on the market in the UK. If CE marking is performed, the procedures in Annex ZA are mandatory. The significance of the CE marking is that the manufacturer claims compliance with the "harmonized" requirements that are regulated in the State in which the product is put on the market, but not necessarily with all of the requirements of the normative text of the standard.

The attestation level required for CE marking is level 4. Therefore, the manufacturer is responsible for the type testing and the production control procedures and no third party involvement is required.

1) In preparation.

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