BRITISH STANDARD

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932-5:2000

Tests for general properties of aggregates —

Part 5: Common equipment and calibration

The European Standard EN 932-5:1999 has the status of a British Standard

ICS 91.100.15

National foreword

This British Standard is the official English language version of EN 932-5:1999. It is included in a package of European Standards declared by CEN/TC 154 and it will supersede BS 812-100:1990 which will be withdrawn on 2003-12-01.

The UK participation in its preparation was entrusted by Technical Committee B/502, Aggregates, to Subcommittee B/502/6, Test methods, which has the responsibility to:

— aid enquirers to understand the text;

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

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

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

Cross-references

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

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 15 and a back cover

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Essais pour déterminer les propriétés générales des granulats - Partie 5: Equipements communs et étalonnage

Prüfverfahren für allgemeine Eigenschaften von Gesteinskörnungen - Teil 5: Allgemeine Prüfeinrichtungen und Kalibrierung

This European Standard was approved by CEN on 16 April 1999.

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 Central Secretariat or to any CEN member.

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

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 154 "Aggregates", 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 May 2000, and conflicting national standards shall be withdrawn at the latest by December 2003.

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

This standard forms part of a series of tests for general properties of aggregates. Test methods for other properties of aggregates will be covered by parts of the following European Standards:

EN 933	*Tests for geometrical properties of aggregates*
EN 1097	*Tests for mechanical and physical properties of aggregates*
EN 1367	*Tests for thermal and weathering properties of aggregates*
EN 1744	*Tests for chemical properties of aggregates*
EN 13179	*Tests for filler aggregate used in bituminous mixtures*

The other parts of EN 932 will be:

Part 1: *Methods for sampling*
Part 2: *Methods for reducing laboratory samples*
Part 3: *Procedure and terminology for simplified petrographic description*
Part 6: *Definitions of repeatability and reproducibility*

In annex A (informative) reference is made to the International Organization for Legal Metrology (OIML) classification which this standard has adopted for the purposes of establishing a frequency of calibration for balance weights.

1 Scope

This European Standard specifies general requirements for common equipment, calibration procedures and reagents for the testing of the properties of aggregates.

2 Normative references

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

EN 933-1, *Tests for geometrical properties of aggregates — Part 1: Determination of particle size distribution- Sieving method*

EN 933-2, *Tests for geometrical properties of aggregates — Part 2: Determination of particle size distribution - Test sieves, nominal size of apertures*

ISO 386, *Liquid-in-glass laboratory thermometers — Principles of design, construction and use*

ISO 3310-1, *Test sieves - Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

ISO 3310-2, *Test sieves - Technical requirements and testing — Part 2: Test sieves of perforated metal plate*

prEN ISO 3650, *Geometrical product specifications (GPS) — Length standards — Gauge blocks (ISO/FDIS 3650:1998)*

ISO 4788, *Laboratory glassware — Graduated measuring cylinders*

ISO 6353-2, *Reagents for chemical analysis — Part 2: Specifications — First series*

ISO 6353-3, *Reagents for chemical analysis — Part 3: Specifications — Second series*

3 Definitions

For the purposes of this standard, the following definitions apply.

3.1
calibration
set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards.

NOTE See ISO 10012-2.

4 Common equipment

4.1 Tolerances

4.1.1 Manufacturing tolerances

4.1.1.1 Linear dimensions

Where a dimension is specified with manufacturing tolerances or limits, it shall be an essential dimension.

NOTE Dimensions stated without tolerances are given for guidance.

4.1.1.2 Mass

Where mass is specified, the manufacturing tolerance shall be ± 1 % of the specified mass unless otherwise stated.

4.1.2 Working tolerances

Working tolerances apply to apparatus after being subjected to wear in use, and shall be not more than twice the manufacturing tolerance unless otherwise specified.

4.2 Measuring instruments

4.2.1 Balances and weights

Balances and weights shall be calibrated. Calibration and checking of balances and weights shall comply with **5.5.1** and **5.5.2** respectively.

NOTE 1 Balances can incorporate an analogue or a digital display.

The balance (and weights if required) selected for a weighing shall enable the mass to be determined to the accuracy required by the test method. If calibration determines that the balance is not suitable for use across its full working range, it shall be labelled to show the upper and lower limits of usable capacity.

NOTE 2 Examples of balances are given in Table 1.

Table 1 — Examples of categories of balances

Capacity g	Scale interval or digit g	Maximum permitted departure from indicated value g
200	0,001	0,005
1 200	0,01	0,05
2 000	0,1	0,3
5 000	0,5	1
10 000	1	3
25 000	5	10
50 000	10	30

4.2.2 Thermometers

Thermometers shall be selected as appropriate to the test method. Graduation intervals or digits shall not be greater than half of the required accuracy of reading.

For liquid-in-glass thermometers the form of graduations shall be as specified in ISO 386. The calibration of thermometers shall comply with **5.5.3**.

4.2.3 Dimensional measurement instruments

4.2.3.1 Steel rules

Steel rules shall have scale divisions at least every 1 mm and shall be checked in accordance with **5.5.4**.

4.2.3.2 Callipers

Digital, dial and vernier callipers for internal and external measurements shall be readable to 0,1 mm or better and shall be calibrated in accordance with **5.5.4**.

4.2.3.3 Micrometers

Micrometer measuring devices shall be readable respectively to 0,01 mm or better, or 0,002 mm or better, depending upon the resolution specified in the test method. Calibration shall be in accordance with **5.5.4**.

4.2.3.4 Dial gauges

Dial gauges shall be readable respectively to 0,01 mm or better, or 0,002 mm or better, depending upon the resolution and range of travel required by the test method. Dial gauges shall be calibrated in accordance with **5.5.4**.

4.2.4 Timers

Timers shall be calibrated in accordance with **5.5.5**.

NOTE 1 Stopwatches or stopclocks readable to 1 s are suitable.

NOTE 2 A suitably placed wallclock with seconds hand, and large enough to read from the work station is an acceptable alternative.

4.2.5 Volumetric glassware

Volumetric glassware complying with class A or B of ISO 4788 shall be used. Class B volumetric glassware shall be checked before initial use in accordance with **5.5.6**.

Where certified volumetric glassware complying with class A of ISO 4788 is used, in-house calibration (see **5.5.6**) is not required.

4.2.6 Ovens

Ovens used for drying aggregates shall incorporate a thermostatic temperature control which can be set to maintain the specified working temperature to within ± 5 °C.

Each oven shall have a temperature indicating device of the required range and accuracy.

Ovens shall be checked in accordance with **5.6.1**.

4.2.7 Test sieves

Test sieves shall comply with EN 933-2. Perforated plate square hole test sieves conforming to ISO 3310-2 shall have an aperture size of at least 4 mm. Woven wire test sieves conforming to ISO 3310-1 shall have an aperture size of less than 4 mm.

Each sieve shall be separately identified. Checks on sieves shall be carried out in accordance with **5.6.3**.

4.2.8 Sieve shakers

Mechanical sieve shakers shall hold securely a nest of sieves with their lid and receiver. Their design shall ensure that the test material on any given sieve progresses over the surface of the sieve when it is agitated.

4.2.9 Desiccators and desiccator cabinets

Desiccators shall be provided with a lid which forms an airtight seal. Desiccator cabinets shall be fitted with a door which forms an airtight seal. Where shelves are fitted they shall permit free vertical circulation of air when the desiccator is in use.

NOTE 1 The most frequently used desiccant is self-indicating silica gel crystals.

NOTE 2 Glass vacuum desiccators should be covered by a safety cage during evacuation, while under vacuum and during vacuum release.

4.2.10 Bottle shakers and rollers

A motorised unit for shaking and/or rotating containers shall be capable of rotating or agitating the containers continuously at the specified speed.

Motorised bottle shakers and rollers shall be calibrated in accordance with **5.6.5**.

4.2.11 Heaters

An electric hotplate shall be fitted with an adjustable control to provide boiling and/or simmering at specified temperatures.

NOTE A Bunsen burner, with tripod and gauze, can be used as an alternative controllable source of heat.

5 Calibration

5.1 Laboratory reference standards

5.1.1 Reference standards for in-house calibration

Where calibration of test measuring instruments is carried out in-house the laboratory shall hold appropriate reference standards or instruments that are used solely for calibration purposes.

Reference standards or instruments shall be retained securely in a suitable environment separate from working standards or instruments when not in use. They shall be used only for calibration purposes and by personnel who are trained in their use.

Reference standards and instruments shall be of an accuracy greater than that of the working device so that the desired accuracy of test measurement is achieved.

Reference standards and instruments shall be calibrated and certified as specified in **5.1.2** and **5.2.**

Re-calibration of reference standards or instruments shall be at intervals not greater than those specified in **5.2** for each type of instrument. Notwithstanding these intervals, whenever a change in accuracy of a reference instrument is suspected, or when a reference instrument has been mishandled, repaired, dismantled, adjusted or overhauled, it shall be re-calibrated before further use.

5.1.2 Calibration and traceability of reference standards

Reference standards and instruments shall be calibrated by an accredited calibration laboratory. The certification shall show traceability to recognised standards of measurement.

NOTE A EUROMET[1)] accredited calibration laboratory complying with EN 45001 or an acceptable international body is suitable.

5.2 Specifications for reference standards and instruments

5.2.1 Reference weights

Reference weights shall be appropriate to the category of balance being calibrated, and shall have a tolerance (maximum permissible error) better than the resolution of the balance to be calibrated. Reference weights shall be identified as such and kept in a secure place, separate from working weights.

Reference weights shall be calibrated when first brought into use. Reference weights of class F_1, F_2 and M_1 shall be re-calibrated every 12 months. Class E_1 and E_2 reference weights shall be re-calibrated every two years.

5.2.2 Reference thermometers and thermocouples

Liquid-in-glass thermometers used as reference thermometers for calibrating laboratory working thermometers shall be calibrated before initial use and re-calibrated or replaced at five year intervals.

An ice point or another appropriate single point check of reference thermometers shall be carried out six months after first being brought into use, then annually in addition to the five year calibration interval requirement.

Calibrated thermocouples and platinum resistance thermometers used as reference instruments shall be re-calibrated at least once a year.

5.2.3 Dimensional standards

Gauge blocks shall comply with ISO 3650 and shall be re-calibrated at five year intervals.

5.3 Calibration and checking of test equipment

5.3.1 Traceability

All measurements necessary for the performance of tests covered by this standard shall be traceable, where this concept is applicable, to national or international standards of measurement through an unbroken process of calibrations. The number of steps in the process shall be no greater than necessary to achieve the required accuracy.

[1] EUROMET is a body comprising European metrology institutes and/or measurement standards laboratories.

5.3.2 External and in-house calibration

5.3.2.1 General requirements

Calibrations shall be carried out either by an external organisation, or in-house by the laboratory's own staff. Systems used shall follow the principles and requirements given in **5.6** and under the relevant test method, where appropriate.

All calibrated equipment shall be used only over the range for which it has been calibrated.

5.3.2.2 External calibration

Wherever possible, all external calibrations shall be carried out by a nationally recognised accredited calibration laboratory. When calibration is carried out under contract by an external organisation, traceability shall be established by the issue of a certificate of calibration for the relevant item. The certificate shall include the following information, and shall be retained on file:

a) the name of the calibrating organisation;
b) for whom calibration was done and at what location;
c) a description of the item calibrated, including identification number;
d) the method of calibration;
e) the equipment used, including reference device(s);
f) the calibration certificate number of the reference device against which the instrument was calibrated, and the traceability route if the calibration is not performed by a recognised accredited calibration laboratory;
g) the calibration temperature;
h) the calibration data and results;
i) the date of calibration;
j) the signature of the person responsible for the calibration;
k) a unique identifier of the certificate (such as a serial number);
l) statement of compliance with the relevant specification;
m) a statement of the uncertainty of measurement of the item.

5.3.2.3 In-house calibration

Calibration shall be carried out in-house only by suitably qualified and experienced staff, in accordance with written procedures for each item. Reference instruments or standards against which working instruments are calibrated shall comply with **5.1**.

Calibration records shall be retained on file and shall include the following information:

a) a description of the item calibrated, including identification number;
b) the method of calibration;
c) the equipment used, including reference device(s);
d) the calibration certificate number of the reference device(s);
e) the calibration temperature;
f) the calibration data and results;
g) the date of calibration;
h) the date when the next calibration is due, if appropriate;
i) the signature of the person responsible for the calibration;
j) a statement of compliance with the relevant specification.

5.4 Frequency of calibration

Routine re-calibration of measuring instruments shall be carried out at intervals that are based on usage and on the analysis of documented calibration data to ensure the required accuracy is not lost between calibrations.

NOTE The periods between re-calibrations specified in **5.5** are the maximum periods for each type of instrument.

Whenever a change in accuracy of an instrument is suspected, or when an instrument has been mishandled, repaired, dismantled, adjusted or overhauled, it shall be re-calibrated before further use.

5.5 Calibration and checking of measuring instruments

5.5.1 Balances

Balances shall be checked, adjusted and calibrated over their working range, using certified reference weights, at least once a year, or at shorter intervals if necessary to prevent the maximum error of readings exceeding the values specified in **4.2.1**.

5.5.2 Weights

Weights shall be calibrated when first brought into use. For weights of class F_1 and below, this shall be every 12 months. For weights of class E_1 and E_2 this shall be every two years (see NOTE).

NOTE Weights are classified according to a tolerance or maximum permissible error as given in *OIML International Recommendation No 20* (see annex **A**). The material of construction and quality of finish also govern classification.

Class E_1 and E_2	Integral stainless steel weights without markings or adjusting chamber (*tolerance ± 0,5 mg/kg or ± 1,5 mg/kg*).
Class F_1	Stainless steel weights which may have a screw knob (tolerance ± 5 mg/kg).
Class F_2	Weights of plated brass (tolerance ± 15 mg/kg).
Class M_1	Weights of brass (which are not corroded or tarnished) or cast iron with a good quality painted finish (tolerance ± 50 mg/kg).

5.5.3 Thermometers

Liquid-in-glass laboratory thermometers complying with ISO 386 shall be calibrated or replaced at intervals not exceeding five years. Other liquid-in-glass thermometers shall be calibrated before first use against a reference standard and shall be re-calibrated or replaced at intervals not exceeding five years.

An ice point or another appropriate single point check of thermometers shall be carried out six months after first being brought into use, then annually in addition to the five year calibration interval requirement.

If thermocouples are used, e.g. for verifying oven temperatures, they shall be calibrated against a reference thermocouple, reference platinum resistance thermometer or reference liquid-in-glass thermometer at least once every six months.

5.5.4 Dimensional measuring instruments

Steel rules shall be checked before use for readability and for wear at their ends at least once a year. Vernier callipers and micrometers shall be calibrated at least once a year against reference gauge blocks.

Dial gauges shall be calibrated at least once a year against a calibrated micrometer device, or in a comparator frame using gauge blocks or length bars.

5.5.5 Timers

Timing devices such as stop clocks and stopwatches shall be calibrated at least once a year to 10 min ± 1 s.

5.5.6 Volumetric glassware

In-house calibration of volumetric glassware shall be carried out by weighing the amount of boiled or de-aired water that the vessel contains or delivers at a measured temperature. A calibrated balance and the temperature correction tables in ISO 4788 shall be used. Volumetric glassware shall be rechecked on a rolling programme at least once every five years.

5.6 Calibration and checking of general apparatus

5.6.1 Ovens

The temperature profile of an empty oven shall be checked before first use and after any major repair or replacement of heater elements and/or thermostat.

The set temperature at the mid-point of the usable oven space of an empty oven shall be checked by means of a calibrated temperature measuring device at least once a year.

NOTE The following procedure is a suitable method for verifying the oven profile, but other procedures may be used providing it can be demonstrated that suitably accurate data can be obtained.

Eight calibrated temperature measuring devices should be used in conjunction with the mid-point device to measure the temperature profile in the usable oven space. Four should be located in the upper one-third of the oven space and four should be located in the lower one-third of the oven space. Each of the eight calibrated temperature devices should be located at least 75 mm from the sides of the oven chamber. The temperature recorded at each of the eight points should be within ± 5 °C of the set temperature as measured at the mid-point of the usable oven space.

5.6.2 Constant temperature bath

Constant temperature water baths shall be checked at least once a year by using a calibrated immersion thermometer at several points within the working area of the bath and observing the temperature when it becomes stable.

NOTE For a given steady room temperature the water temperature control setting can be calibrated against various water temperatures by repeating the procedure over a range of settings.

5.6.3 Test sieves

5.6.3.1 Visual checks

All sieves shall be checked by the operator before each use. A detailed visual check shall be made of the condition of every sieve at regular intervals depending on use.

The visual checks shall identify any damage, scoring, or blinding which is likely to affect the performance of the sieve. If any doubt exists, a measurement or performance check, as appropriate, shall be carried out before further use.

Test sieves which fail visual checks shall be clearly marked as such, and be either discarded or used as guard sieves where appropriate.

5.6.3.2 Perforated plate test sieves

The apertures of perforated plate test sieves shall be measured in accordance with ISO 3310-2 at least once every two years.

NOTE Other optical methods may also be used as a method of examination.

5.6.3.3 Woven metal wire cloth test sieves

The apertures of woven wire cloth test sieves shall be either measured in accordance with ISO 3310-1 at least once a year or the apertures of woven wire cloth test sieves shall be subject to a performance check at regular intervals, depending on use, by means of the method specified below.

NOTE Other optical methods can also be used as a method of examination.

A performance check sample, consisting of rounded or sub-rounded particles, shall be prepared for each sieve size to be checked. The performance check sample shall be uniformly graded and shall comply with Table 2.

Table 2—Grading of the performance check sample for test sieve of aperture size equal to *d* mm

Test sieve aperture size (mm)	Percentage passing
The nearest size above 2 *d*	100
d	40 to 60
0,5 *d* or the nearest size below 0,5 *d* in the EN 933-2 series if 0,5 *d* is not an actual size in this series	0 to 5
NOTE: The requirement for test sieve size 0,5 *d* shall not apply if 0,5 *d* is less than 63 µm.	

The mass of the performance check sample shall be chosen to be not less than 50 % but not more than 100 % of the maximum retained mass specified in EN 933-1.

Each size of working sieve shall have an associated master sieve of the same aperture size. The master sieve shall not have been used previously for any other purpose and shall be retained exclusively for use as a master sieve until its replacement is due. This shall be after 200 uses or eight years, whichever occurs earliest.

The performance check procedure (see NOTE 1) shall be carried out before first use of the working sieve. The check procedure shall be to dry-sieve the performance check sample consecutively over both the master sieve and the working sieve using identical methods until a defined end point is reached. Calculate the difference between the percentage mass passing the master sieve and the percentage mass passing the working sieve, and record this value.

After an appropriate interval (see NOTE 2), the performance check procedure shall be repeated using other performance check samples (see NOTE 3). A working sieve shall be considered as failing the performance check procedure if the value of the difference has changed by more than 5 when compared with the value recorded before first use.

Working sieves that are in use at the time of their first performance check shall be considered as giving performance equivalent to first use if the value of the difference is not more than 5 at the first check.

Test sieves which fail measurement or performance checks shall be clearly marked as such, and be either discarded or used as protection sieves where appropriate.

Where suitably certified "reference samples" are available, master sieves need not be used.

NOTE 1 Performance check procedure establishes the difference between a new test sieve and a master sieve. The procedure monitors the rate of the wear of the test sieve to an accuracy which is consistent with the manufacturing tolerances for the test sieve and the tests in which they are used.

NOTE 2 Wear and tear on sieves is very dependent on their manner of use and the abrasiveness of the material being tested. Until such time that the laboratory has sufficient records to indicate rates of wear and thus fix rational check periods, performance checks should be at intervals of not more than 3 months.

NOTE 3 The performance check sample can be kept for further use. Provided appropriate measures are taken to control degradation and loss of particles from the performance check sample, it may not be necessary to use the master sieve for every performance check.

5.6.4 Moulds

Items of equipment such as moulds shall be checked by determining their essential dimensions and mass where applicable. These determinations shall be carried out on items before first use and shall be repeated at intervals, depending on frequency of use, to allow for wear. When the change due to wear exceeds the permitted working tolerances the item shall not be used.

5.6.5 Bottle shakers and rollers

The speed of oscillation or rotation of machines used for shaking or rolling bottles and gas jars shall be calibrated at least once a year with the shaker or roller fully laden.

5.6.6 Rotating machinery

Where the speed of rotation of an item of machinery is critical to the test method; the speed expressed in revolutions per minute (r/min), or the equivalent rate, shall be checked at least once a year using a calibrated instrument such as a tachometer. The machinery shall be normally loaded during the check procedure.

5.6.7 Vibrating Machinery

Where the frequency of vibration of an item of machinery is critical to the test method, then the frequency shall be checked at least once a year using a calibrated instrument. The machinery shall be normally loaded during the check procedure.

6 Reagents

6.1 Distilled water

Where distilled water is required it shall be produced by distillation or by the use of de-ionising apparatus. Distilled or de-ionised water shall comply with the following requirements:

a) non-volatile residue, not more than 5 mg/l of residue;

b) pH value, not lower than 5,0 and not higher than 7,5.

6.2 Chemical reagents

Chemical reagents used shall be of analytical quality, e.g. AR grade reagents (in accordance with ISO 6353-2 and ISO 6353-3).

NOTE Grades other than AR grade chemical reagents may be used where permitted by the test method.

Annex A (informative)

Bibliography

ISO 10012-2:1997 *Quality assurance for measuring equipment Part 2: Guidelines for control of measurement processes.*

EN 45001:1989 *General criteria for the operation of testing laboratories.*

International Organisation for Legal Metrology (OIML), Internal Recommendation No 20, Weights of Accuracy, classes E_1, E_2, F_1, F_2, M_1, from 50 kg to 1 mg.

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