BRITISH STANDARD

BS EN 932-1 : 1997

Tests for general properties of aggregates

Part 1. Methods for sampling

The European Standard EN 932-1 : 1996 has the status of a British Standard

ICS 91.100.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee B/502, Aggregates, upon which the following bodies were represented:

Association of Consulting Engineers
Association of Lightweight Aggregate Manufacturers
British Aggregate Construction Materials Industries
British Cement Association
British Iron and Steel Producers' Association
British Precast Concrete Federation Ltd.
British Ready Mixed Concrete Association
Department of the Environment
Department of the Environment (Building Research Establishment)
Department of Transport (Highways Agency)
Electricity Association
Institute of Concrete Technology
Institution of Civil Engineers
Institution of Structural Engineers
Sand and Gravel Association Limited
Society of Chemical Industry

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Civil Engineering Test Equipment Manfacturers' Association
County Surveyors' Society
Department of Trade and Industry (National Measurement Accreditation Service)

This British Standard, having been prepared under the direction of the Sector Board for Building and Civil Engineering, was published under the authority of the Standards Board and comes into effect on 15 May 1997

Amendments issued since publication

Amd. No.	Date	Text affected

The following BSI references relate to the work on this standard:
Committee reference B/502
Draft for comment 92/19731 DC

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Contents

National foreword

This British Standard has been prepared by Technical Committee B/502. It is the English language version of EN 932-1 : 1996 *Tests for general properties of aggregates — Part 1: Methods for sampling* published by the European Committee for Standardization (CEN).

It forms part of a group of European Standards dealing with test methods for aggregates which are being developed by CEN/TC 154 to verify requirements which will be specified in European product standards for aggregates for various end uses.

It is intention that this standard will be included in a 'package' of European Standards to be declared by CEN/TC 154 and when all the associated European test methods for aggregates are available, this Part of this European Standard will supersede BS 812 : Part 102 : 1989 *Testing aggregates Part 102. Methods for sampling*.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 18, an inside back cover and a back cover.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 932-1

August 1996

ICS 91.100.21

Descriptors: Aggregates, sampling, samples, samplers, marking

English version

Test for general properties of aggregates — Part 1. Methods for sampling

Essais pour déterminer les propriétés générales des granulats —
Partie 1: Méthodes d'échantillonnage

Prüfverfahren für allgemeine Eigenschaften von Gesteinskörnungen —
Teil 1: Probenahmeverfahren

This European Standard was approved by CEN on 1996-07-26. 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.

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

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

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 932-1 : 1996 E

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 February 1997, and conflicting national standards shall be withdrawn at the latest by February 1997.

This European Standard is one of a series of standards for tests for general properties of aggregates as listed below.

prEN 932-2:	*Tests for general properties of aggregates Part 2: Methods for reducing laboratory samples*
EN 932-3:	*Tests for general properties of aggregates Part 3: Procedure and terminology for simplified petrographic description*
prEN 932-4:	*Tests for general properties of aggregates Part 4: Quantitative and qualitative system for description and petrography*[1)]
prEN 932-5:	*Tests for general properties of aggregates Part 5: Common equipment and calibration*
prEN 932-6:	*Tests for general properties of aggregates Part 6: Definitions of repeatability and reproducibility*
prEN 932-7:	*Tests for general properties of aggregates Part 7: Conformity criteria for test results*[1)]

Test methods for other properties of aggregates are 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*

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

Contents

[1)] In course of preparation.

1 Scope

This European Standard specifies methods for obtaining samples of aggregates from deliveries, preparation and processing plants including stocks.

The aim of sampling is to obtain a bulk sample that is representative of the average properties of the batch.

The methods specified in this standard are also suitable for obtaining sampling increments which may be tested separately.

Methods to be used for sample reduction are also given.

The methods specified in this European Standard are based on manual procedures. Mechanical, or automatic sampling and sample reduction may also be used. Criteria for the design and the assessment of such equipment are given in annex A.

The methods specified in this European Standard are limited to civil engineering purposes.

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.

prEN 932-5 *Tests for general properties of aggregates Part 5: Common equipment and calibration*

3 Definitions

For the purposes of this European Standard, the following definitions apply:

3.1 batch

A production quantity, a delivery quantity, a partial delivery quantity (railway wagon-load, lorry- load, ship's cargo) or a stockpile produced at one time under conditions that are presumed uniform.

NOTE. With a continuous process the quantity produced during an agreed period is treated as a batch.

3.2 sampling increment

A quantity of material taken from a batch by one operation of the sampling apparatus.

3.3 bulk sample

An aggregation of the sampling increments.

3.4 representative sample

A bulk sample created by taking sampling increments according to a sampling plan, which makes it likely that the quality of this sample corresponds to that of the batch.

3.5 subsample

A sample obtained from sampling increments or a bulk sample by means of a sample reduction procedure.

3.6 laboratory sample

A reduced sample derived from a bulk sample for laboratory testing.

3.7 sampler

An individual, a number of individuals working as a team, or an organization, taking samples on a routine basis.

4 Principles of sampling

Proper and careful sampling and sample transport is a prerequisite for an analysis that will give reliable results. The correct use of the specified apparatus helps to avoid biased sampling. Sampling variation caused by the heterogeneity of the batch is reduced to an acceptable level by taking an adequate number of sampling increments. If the aggregate is homogenized by production processes, one large increment may be representative of the batch.

Sampling increments are selected at random from all parts of the batch that the bulk sample is to represent. Aggregate from which no sampling increment can be taken (because it is not accessible, or for some other practical reason) shall not be considered to be part of the batch that is represented by the bulk sample. For example, if sampling increments are taken from aggregate discharged from a silo, the bulk sample represents the aggregate that has been discharged, not the aggregate remaining in the silo.

The sampler shall be informed of the aim of the sampling.

5 Bulk sample and sampling increment quantity and number

The bulk sample quantity shall be calculated taking into account the nature and number of tests, the aggregate sizes, and the density of the aggregate. If there is a need for testing separate sampling increments, instead of the bulk sample, the quantity of the sampling increments shall be calculated on the same parameters as given above. Choose the number of sampling increments taken to form the bulk sample on the basis of past experience of sampling similar aggregates from similar production processes. This experience shall preferably be the recorded result of experiments.

NOTE 1. It is recommended that the minimum mass of a bulk sample be calculated in accordance with the following equation:

$$M = 6 \times \sqrt{D} \times \rho_b$$

where:

M is the mass of the sample, in kilograms;

D is the maximum grain size, in millimetres;

ρ_b is the loose bulk density, in megagrams per cubic metre, determined as specified in prEN 1097-3.

NOTE 2. A procedure that producers can use to check that they are taking numbers of sampling increments that are adequate for their products and processes is given in annex B.

6 Sampling plan

A sampling plan shall be prepared, prior to sampling, taking into account the aggregate size, the nature and size of the batch, the local circumstances and the purposes of sampling. It shall include:

– the type of the aggregates;

– the aim of the sampling including a list of the properties to be tested;

– the identification of the sampling points;

– the approximate mass of sampling increments;

– the number of sampling increments;

– the sampling apparatus to be used;

– the methods of sampling and sample reduction with reference to the clauses of this European Standard;

– the marking, packaging and dispatch of the samples.

7 Apparatus

All apparatus shall comply with the general requirements of prEN 932-5.

NOTE 1. General advice for apparatus to be used in sampling and sample reduction is given in annex A.

In all cases the width w of the opening of apparatus used in sampling shall be not less than three times the upper aggregate size of the batch and in no case less than 10 mm.

NOTE 2. The same applies to the dimensions indicated in the figures of annex A.

Equipment to be used in sample reduction is also given in annex A.

NOTE 3. In all cases, alternative designs may be used so long as the essential dimensions of width of opening and length are met and the devices can be used to fulfil the sampling methods described in clause **8** or the reduction methods described in clause **9**.

8 Sampling procedures

8.1 General

Regulations for safety and ergonomics shall be followed.

NOTE 1. The sampling methods will inevitably involve the samplers working close to processing plant and moving vehicles. Those involved in the planning and execution of sampling should work closely with the operational management to ensure safe working practices.

NOTE 2. Aggregates should preferably be sampled from a stationary conveyor belt or from the stream of material. Sampling increments should be taken at regular intervals throughout the period the batch is in motion.

NOTE 3. When sampling from stockpiles as described in **8.8** is carried out, it is difficult to satisfy the principle of taking sampling increments at random from all parts of the batch, so that segregation can cause the sampling to produce biased results. Therefore, this method, wherever possible, should be avoided.

Manual sampling with shovels or scoops etc shall not be applied to moving materials.

8.2 Sampling from stationary conveyor belts

NOTE 1. Sampling should only be started after a preliminary run to ensure that possible irregularities in the pass do not cause a false sample to be taken.

All sampling increments shall be taken at the same sampling point. The material shall be taken across the complete cross section of the belt in every sampling increment.

NOTE 2. The sampling frame (see **A.3**) should be used to separate the material that is to be taken as the sampling increment at the sampling point. As an alternative to the use of the sampling frame a shovel or a flat piece of metal can be used to separate the sampling increment at both ends from the material remaining on the belt. This increment should have the length of about three times the width of the material stream on the belt or a minimum mass as calculated according to the equation given in clause **5**.

8.3 Sampling at belt and chute discharge points

NOTE 1. Mechanical apparatus provides the most practical means of taking samples from belt and chute discharge points. Manual sampling should be avoided if possible, due to both errors and dangers involved.

The period during which the sampling is to be done shall be divided into a number of equal intervals, and a sampling increment shall be taken in the middle of each interval.

A sampling increment shall be taken by passing the sampling receptacle e.g. the sampling box (see **A.4**) through the discharge stream in a uniform movement, making sure that the complete cross section of the stream of material is intercepted.

NOTE 2. Where appropriate, sampling should only be started after a preliminary run to ensure that possible irregularities in the pass do not cause a false sample to be taken.

NOTE 3. Samples can also be taken at the discharge from a screen by the same method.

8.4 Sampling of pneumatically transported aggregates

Sampling from the pneumatic transport in a plant shall be carried out in accordance with **8.3** and by means of sampling equipment installed by the producer.

This sampling equipment, mostly based on a by-pass principle, shall be designed in such a way that the whole stream of the aggregate can be interrupted to form an increment through the bypass.

8.5 Sampling of packed aggregates

When aggregate is packed in bags, drums or other small containers, a bulk sample shall be obtained by selecting a number of packs at random.

NOTE. A whole pack can be taken as a sampling increment, or the sampling spear (see **A.6**) used to take one sampling increment from each of the selected packs, or each of the selected packs can be reduced by one of the procedures described in clause **9**.

Whenever possible random selection of packs shall be achieved by selecting packs at random times as they pass a chosen sampling point during loading or unloading, or by numbering all the packs and using random numbers (see annexes D and E).

8.6 Sampling of material in bucket conveyors, bucket loaders, or grabs

Each sampling increment shall consist of the entire contents of a grab or bucket.

NOTE. When this gives too large a sampling increment, it should be reduced by one of the methods described in clause **9**, or discharged to form a small stockpile and sampled according to **8.8**.

8.7 Sampling from a silo

Sampling at an outlet shall be carried out in accordance with **8.3**.

The silo shall be opened sufficiently to ensure a uniform material flow without segregation; this requires an aperture at least three times the diameter of the maximum grain diameter. For aggregates with a lower size above 32 mm an aperture of at least 200 mm is required.

8.8 Sampling from stockpiles

Sampling increments of approximately equal size shall be taken from different points at different heights or depths, distributed over the complete stockpile (see figure 1). The location and number of sampling increments shall take into account the way in which the stockpile was built, its shape and the possibility of segregation within the stockpile. A sampling increment shall be taken using a scoop (see **A.1**), a shovel (see **A.2**) or a grab (**A.7**) from the deepest point of each hole.

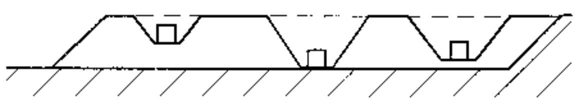

Figure 1. Sampling from flat stockpiles

NOTE. Conical stockpiles present special problems. Further guidance on sampling from such stockpiles is given in annex C.

8.9 Sampling from railway wagons, lorries and ships

Sampling of single-sized aggregates and of free flowing fine aggregate from lorries may be carried out as described in **8.8**.

Sampling of fine aggregate from lorries may also be carried out by using the sampling tube (see **A.5**); each sampling increment shall be taken by inserting the tube vertically down through the full depth of the aggregate.

In other situations, proper sampling from railway wagons, lorries or ships may not be possible. Sampling shall therefore be carried out wherever possible during loading or discharge according to **8.2, 8.3** or **8.6**. Only when this is not possible, the aggregate shall be discharged to form a stockpile and sampled according to **8.8**.

9 Sample reduction

9.1 General

The procedure described in **9.2** shall preferably be used for the preparation of laboratory samples from bulk samples of aggregates. The procedures described in **9.4**, **9.5** and **9.6** may be used when the other methods are not suitable or the devices are not available. All the procedures may also be used in combination, for example by using quartering for the first few reduction stages followed by riffling.

NOTE. For all-in aggregates with an upper aggregate size of more than 63 mm, it may be suitable to remove aggregates coarser than 63 mm and treat them separately.

If necessary, the bulk sample shall be brought to a condition in which it is free-flowing but not so dry that fines will be lost or accretion occurs.

For mixing, and other operations that require a working surface, use a clean, flat, hard surface such as a sampling tray (see **A.9**) or a glass plate (for fillers). If a shovel is required it shall be in accordance with clause **7**.

If a rotatory sample divider is available it is preferred for sample reduction.

9.2 Reduction of a bulk sample using a riffle box

Put the bulk sample into one of the riffle box (see **A.10**) receptacles and place the other two in position. Pour the aggregate from the long side of the receptacle down the centre line of the riffle box. Discard the aggregate that falls into one of the other two receptacles. Repeat as many times as are needed to arrive at the required size of laboratory sample.

If the bulk sample is too large to go into the riffle box receptacle, divide up the bulk sample into subsamples that are small enough, reduce each by the same number of riffling stages, then combine the reduced subsamples.

9.3 Reduction of sampling increments using a riffle box

When the sampling increments have been kept separate, use the procedure described in **9.2** to reduce each increment by the same number of riffling stages. If required, combine the reduced sampling increments to form the laboratory sample.

9.4 Reduction of a bulk sample by quartering

Place the bulk sample on the working surface and mix it thoroughly by heaping it up to form a cone, and turning it over with the shovel to form a new cone.

Repeat this operation three times. When forming the cones, deposit each shovelful on the peak of the new cone in such a way that the aggregate runs down all sides of the cone and is evenly distributed so that the different sizes become well-mixed.

Flatten the third cone, by inserting the shovel repeatedly and vertically into the peak of the cone, to form a flat heap which has a uniform thickness and diameter.

Quarter the flat heap along two diagonals intersecting at right angles (see figure 2). Discard one pair of opposite quarters and shovel the remainder into a stockpile.

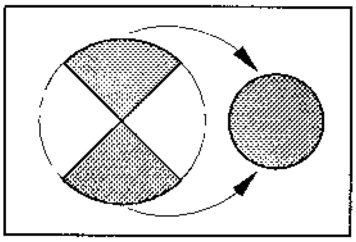

Figure 2. Reduction of a sample by quartering

Repeat the process of mixing and quartering until the required size of laboratory sample is obtained.

NOTE. The use of a plate or a quartering cross of wood or sheet metal which can be forced down through the heap, often facilitates quartering in cases where the material tends to segregate.

9.5 Reduction of sampling increments by quartering

When the sampling increments have been kept separate, use the procedure described in **9.4** to reduce each increment by the same number of quartering and mixing stages. If required, combine the reduced sampling increments to form the laboratory sample.

9.6 Sample reduction by fractional shovelling

Fractional shovelling is a method of sample reduction in which a bulk sample is divided into a number of subsamples of approximately equal mass, one (or more) of which is then retained as the laboratory sample.

Determine the approximate mass m (in kilograms) of the bulk sample, and the number n of subsamples to which it is to be reduced. Use a shovel that can hold at most a mass (in kilograms) of $m/(30n)$ of the aggregate.

Take shovelfuls from the bulk sample and add them to each of the n subsamples in turn, until the whole of the bulk sample has been used.

NOTE. For fractional shovelling, a shovel can be any item of equipment that can be used to pick the aggregate off the working surface, for example, a chemist's spatula or a mechanical shovel.

Using random numbers (see annexes D and E), randomly select the subsample, or subsamples, that are to be retained.

10 Marking, packaging and dispatch of the samples

The samples or containers shall be clearly and durably marked.

Marking shall include:

a) a unique code, or

b) identification of the laboratory samples, place of sampling, date of sampling, and designation of the material.

The laboratory samples shall be packed and transported in such a way that their condition at the time of sampling is preserved; e.g. all-in aggregate shall be packed in clean containers such that fines cannot be lost during transportation. If necessary, e.g. in order to preserve the moisture or volatiles content of the laboratory samples, the containers shall be given an air-tight closure.

11 Sampling report

The sampler shall prepare a sampling report for each laboratory sample or for each group of laboratory samples from a single source. The sampling report shall refer to this European Standard and state:

a) the sampling report identification (serial number);

b) the laboratory sample identification mark(s);

c) the date and place of sampling;

d) the grading type and size of the batch;

e) sampling point or identification of the batch sampled;

f) a reference to the sampling plan prepared according to clause **6**;

g) the name of sampler(s).

NOTE. Depending on the circumstances other information can be relevant. Figure 3 shows an example of a comprehensive sampling report.

EN 932-1 Sampling report identification (serial number):

Laboratory sample identification mark: Number of packages:

Description of aggregate sampled

Name of pit or quarry or production plant:
Name of producer:
Type: Crushed rock/sand/gravel/... inland/marine
Uppper aggregate size:
Nature of batch: Stockpile/Silo/Railway wagon/...
Purpose for which the aggregate is to be used:
Location of sampling point(s):
Identification of batch:
Size of batch:
Other comments (e.g warnings if appropriate):

Description of the sampling method

Date and time of sampling:
Reference to sampling plan used, if written:
Weather condition at the time of sampling:

Sampling procedure used (see clause **8**):
Apparatus used: box/frame/spear/tube/scoop/shovel/mechanical
Mass of sampling increments:
Number of sampling increments:
Other comments:
Method of sampling reduction:
Dispatch of the samples:
Sampler - Print name:

Contract details

Contract identification:
Name and address of party requesting the sampling: ....
Names of persons present at sampling: ....

Signatures: ....

Figure 3. Example of a sampling report

Annex A (informative)

Examples of equipment for sampling and sample reduction

A.1 Scoop (see figures A.1 and A.2)

Requirements for dimensions are given in clause **7**.

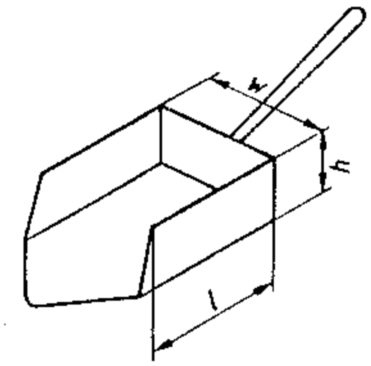

Figure A.1 Example of a sampling scoop with a rectangular cross-section

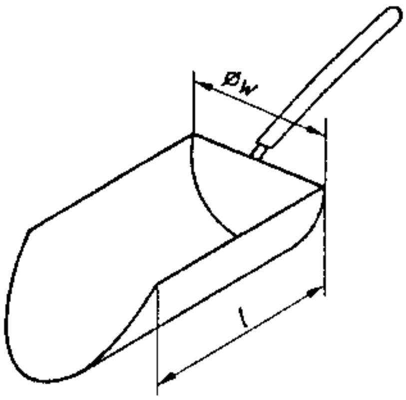

Figure A.2 Example of a sampling scoop with a circular cross-section

A.2 Shovel (see figure A.3)

Requirements for dimensions are given in clause **7**.

A.3 Sampling frame (see figure A.4)

The sides of the sampling frame are parallel and shaped to fit the conveyor belt and their length is approximately the breadth of the belt. The sides of the sampling frame are high enough to prevent particles spilling over the top. The opening *w* is at least three times the maximum particle size.

A.4 Sampling box (see figure A.5)

The sides of the sampling box are vertical and opposite sides are parallel. The edges around the top of the sampling box are rounded. The capacity of the sampling box is such that it is not more than half-filled by a sampling increment. The width *w* of the opening complies with clause **7**. The length *l* of the opening is large enough to allow the complete stream of material to be intercepted. The depth of the sampling box is such that no particles are lost by jumping out of the box.

A.5 Sampling tube (see figure A.6)

The sampling tube consists of two tubes, one inside the other.

Both tubes have openings down their operational lengths, so that by turning one tube relative to the other, aggregate is allowed to enter the sampling tube and is then trapped in it.

The length *l* of the sampling tube is between 1000 mm and 2000 mm. The width *w* of the openings of the inner and outer tubes conforms to clause **7**. The wall thickness of the tubes are such that they will withstand normal use without deformation.

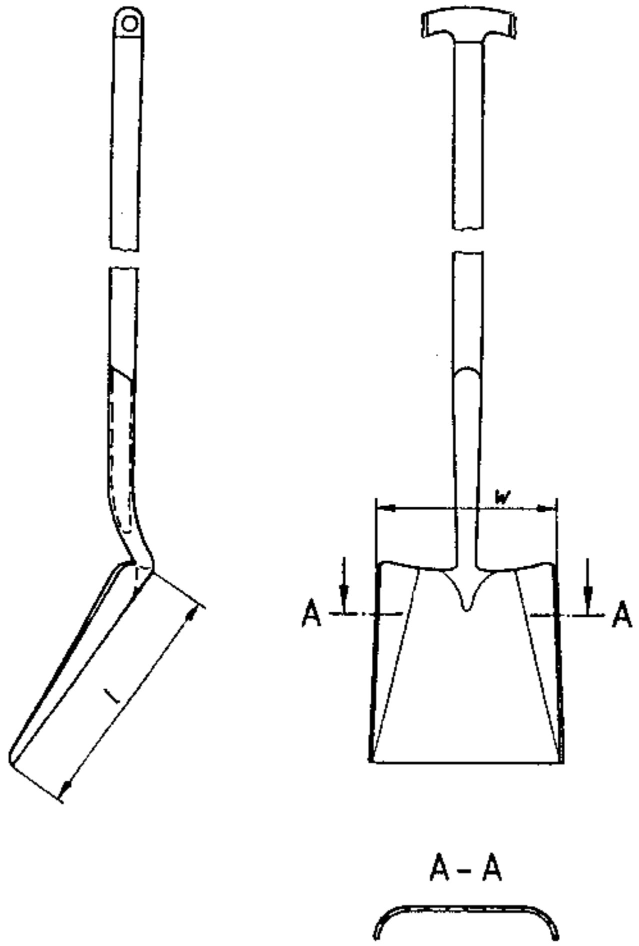

Figure A.3 Examples of a shovel

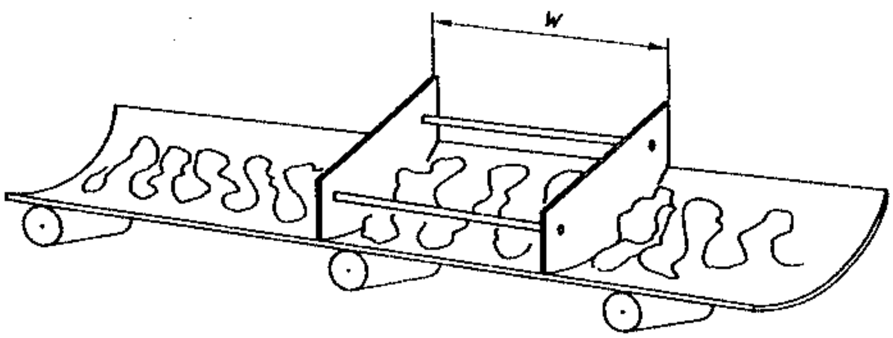

Figure A.4 Example of a sampling frame

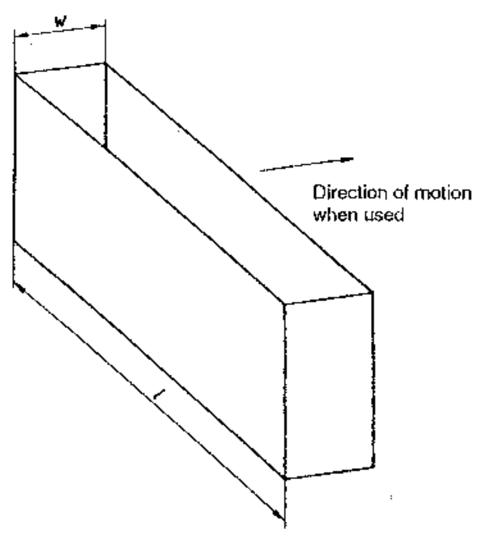

Figure A.5 Example of a sampling box

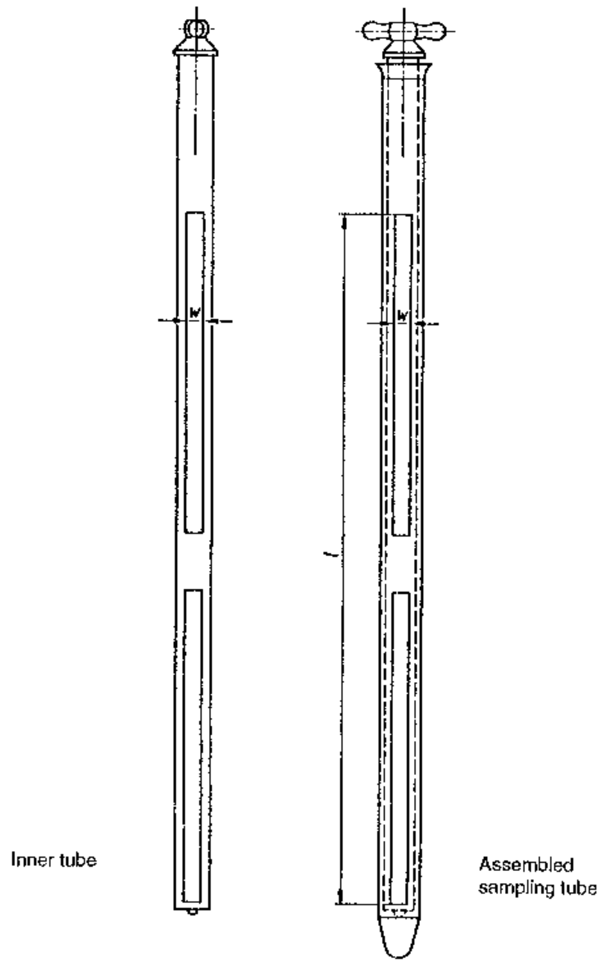

Figure A.6 Example of a sampling tube

A.6 Sampling spear (see figure A.7)

The sampling spear is a long, smooth tube with an obliquely cut front end.

For sampling from stockpiles, the length l of the sampling spear is between 1000 mm and 2000 mm. The internal diameter w of the sampling spear conforms to clause **7**. For sampling from packs the sampling spear should be long enough to reach all the material in the pack.

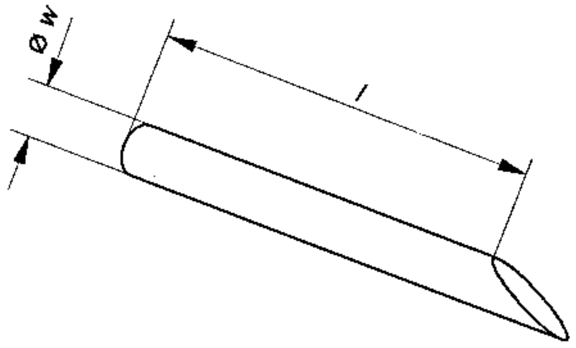

Figure A.7 Example of a sampling spear

A.7 Sampling buckets and grabs

Requirements for dimensions are given in clause **7**.

A.8 Criteria for mechanical sampling apparatus

Apparatus for mechanical sampling is designed so that every particle in a batch has an equal probability of being included in the bulk sample.

The design should ensure that:

– no overflow nor spillage of increments takes place;

– no clogging or impedance of the flow of aggregate takes place in the apparatus;

– there is a complete emptying of the sample container;

– no materials (for example, material from belt scrapers and pulleys), other than the aggregate to be sampled, is introduced into the increments;

– reduction in size, or breaking, of the particles is kept to a minimum;

– the apparatus cuts a complete cross-section of the aggregate stream clearing the stream;

– the apparatus cuts the aggregate stream either in a plane perpendicular to, or along an arc normal to, the mean trajectory path of the stream;

– the apparatus travels within the aggregate stream at the same uniform speed each time an increment is taken;

– the geometry of the cutting aperture allows each point in the stream to be cut for the same length of time;

– the width of the cutting aperture complies with the requirements for w in clause **7**.

– the speed of the cutter does not exceed $0{,}3(1 + w_0/w)$ m/s where w is the actual width of the cutting aperture, and w_0 is the minimum value allowed in clause **7**.

NOTE 1. ISO 1988 and ISO 3082 (see annex E) give advice on the design and checking of machines suitable for the work and give figures showing the principles of mechanical sampling apparatus.

NOTE 2. In connection with automated sampling, riffling devices other than the riffle box are acceptable, provided the recommendations of **A.10** are followed.

A.9 Sampling tray

The sampling tray should be made from smooth, corrosion-resistant material, large enough to mix the sample without spillage.

A.10 Riffle box (see figure A.8)

The number of slots of the riffle box is even and not less than eight. The width of the slots should be at least twice the upper aggregate size to avoid bridging.

A.11 Rotatory sample dividers

Examples of rotary sample dividers (see **9.1**) for coarse aggregates and fine aggregates are given in figures A.9 and A.10.

A.12 Containers

Containers for transport are clean, impervious, and non-absorbent, such as bags made of plastics at least 100 μm thick or buckets.

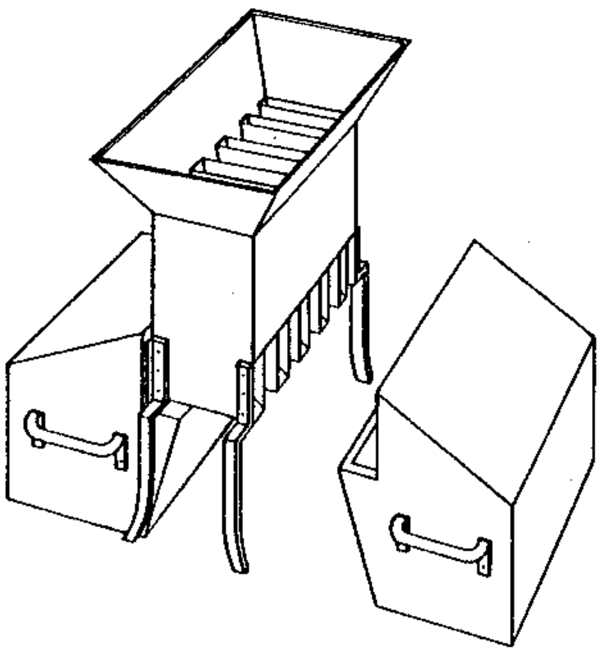

Figure A.8 Example of a riffle box

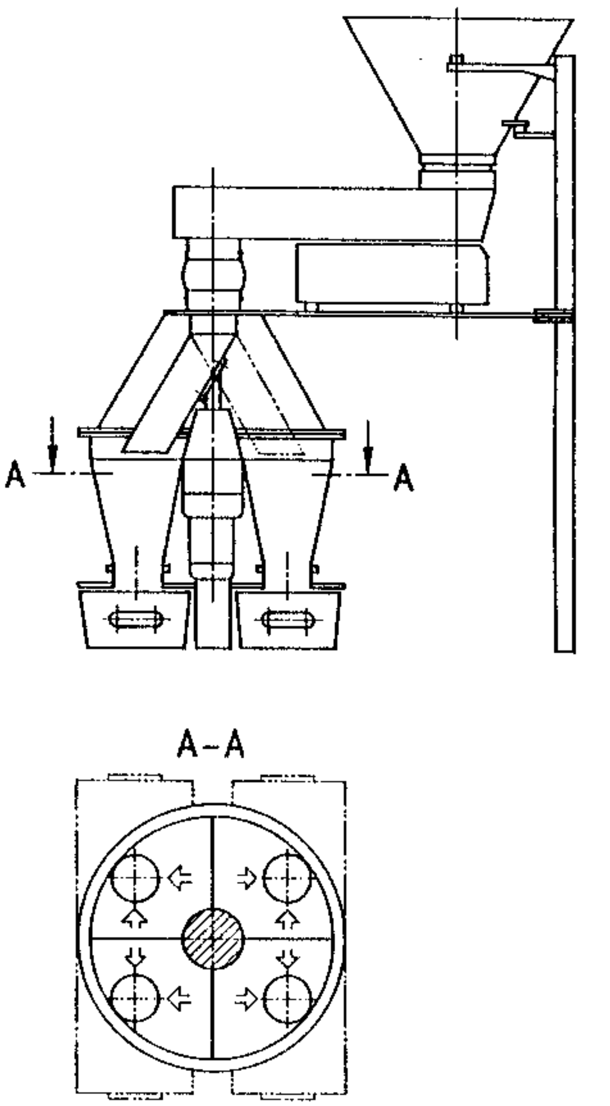

Figure A.9 Example of a rotary sample divider for coarse aggregate

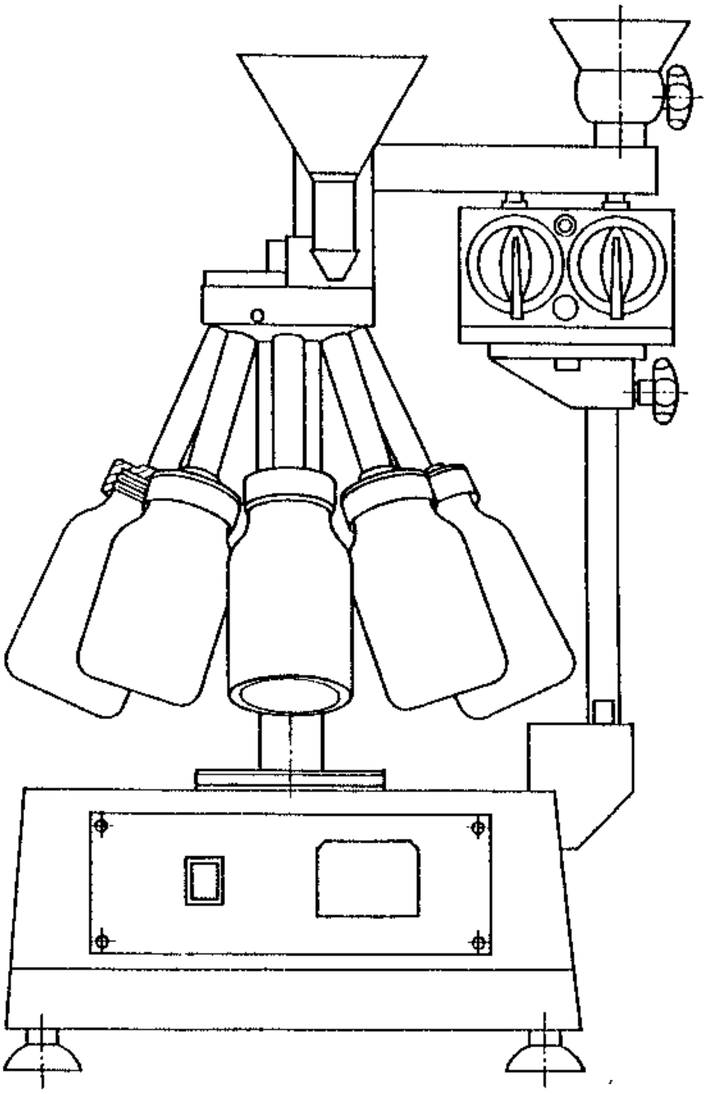

Figure A.10 Example of a rotary sample divider for fine aggregate

Annex B (informative)

Measurement of sampling variation

B.1 Introduction

This procedure can be used to check that the number (k) of sampling increments taken to obtain bulk samples is adequate for the test method used in the procedure. It allows the size of the sampling standard deviation to be measured and compared with the repeatability standard deviation. If the sampling standard deviation exceeds the repeatability standard deviation the number of sampling increments should be increased from k to k' (see **B.4**).

B.2 Procedure

Using the sampling method that is to be assessed, duplicate bulk samples are taken on at least fifteen occasions. Each bulk sample is reduced to a laboratory sample, then two test portions are produced from each laboratory sample. A test result on each test portion is obtained using the test procedure chosen for the purpose.

The sampling occasions may be spread over an extended period.

B.3 Calculations

The following equations are valid only for duplicate sampling.

n	is the number of occasions on which duplicate bulk samples are taken.
i =	1, 2 ... n is used to denote the occasions.
A and B	are used to distinguish the two bulk samples taken on an occasion.
m_{Ai}	is the mean of the two test results from sample A occasion i.
m_{Bi}	is the mean of the two test results from sample B occasion i.

d_{Ai} is the difference between the two test results from sample A occasion *i*.

d_{Bi} is the difference between the two test results from sample B occasion *i*.

Calculation:

Overall mean:	$\bar{x} = \Sigma\,(m_{Ai} + m_{Bi})/(2n)$
Repeatability variance:	$V_r = \Sigma\,(d^2_{Ai} + d^2_{Bi})/(4n)$
Variance between samples:	$V_s = \Sigma\,(m_{Ai} - m_{Bi})^2/(2n)$
Repeatability standard deviation:	$\sigma_r = \sqrt{V_r}$
Sample standard deviation:	$\sigma_s = \sqrt{(V_s - 0{,}5V_r)}$

B.4 Adjustment of number of increments

If $\sigma_s > \sigma_r$, then the number of sampling increments used is increased to obtain bulk samples for the test method used in the assessment.

A suitable number of sampling increments k' can be estimated by the following equation:

$$k' = k\,(\sigma_s/\sigma_r)^2$$

where

k' is the required number of sampling increments;

k is the number of sampling increments taken per bulk sample in **B.2**;

σ_r is the repeatability standard deviation;

σ_s is the sample standard deviation.

Annex C (informative)

Examples of methods for sampling conical stockpiles

C.1 Sampling from the interior of a stockpile using a loader

Aggregate in a stockpile is likely to be segregated, so it is better, whenever possible, to sample from the interior, and not take sampling increments only from near the surface. This is particularly true for coarse aggregates.

A loader is used to expose a sampling face across the interior of the stockpile. A number of bucket loads are taken from over the sampling face and used to form a sampling stockpile, then a shovel is taken to take a number of sampling increments from positions chosen at random throughout the stockpile.

C.2 Sampling stockpiles of fine aggregates by hand

Generally sampling by hand is only possible close to the surface.

In a cone-shaped stockpile of fine aggregate (with a base that is approximately circular), in which no regular patterns of segregation occur, the quantities will be as shown in figure C.1, so take nineteen times as many sampling increments from the bottom one-third of the stockpile, and seven times as many from the middle one-third, as from the top one-third.

In a prismatic stockpile of fine aggregates (in which the base is much longer in one direction than the other), in which no regular patterns of segregation occur, the quantities will be as shown in figure C.2, so that five times as many sampling increments are taken from the bottom one-third of the stockpile, and three times as many from the middle one-third, as from the top one-third.

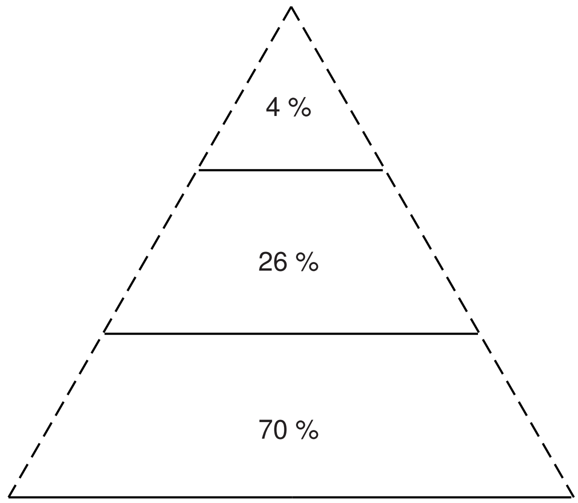

Figure C.1 Volume distribution in a cone-shaped stockpile of fine aggregates or single-sized aggregates (1 : 7 : 19)

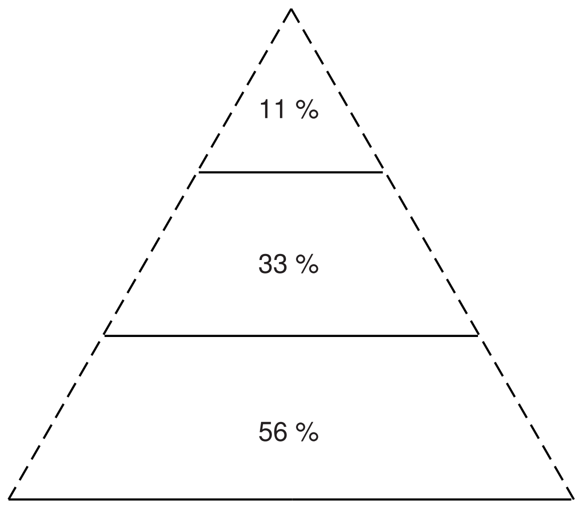

Figure C.2 Volume distribution in a prismatic stockpile of fine aggregates or single-sized aggregates (1 : 3 : 5)

Driving a board or metal plate into the stockpile at the appropriate point and then taking the sampling increment immediately below it, prevents surface material falling into the hole. (See figure C.3, arrangement a). The surface of the stockpile should be removed to a depth of at least twice the upper aggregate size before taking a sampling increment.

This procedure may not be possible with coarse material.

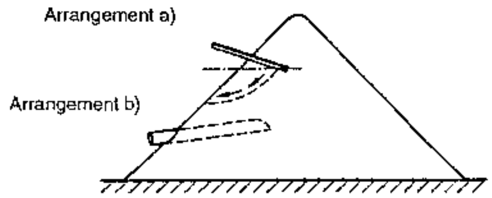

Figure C.3 Sampling from conical stockpiles using board or metal plate (arrangement a) and using a spear with oblique end (arrangement b)

Sampling spears (see **A.6**) can also be suitable for sampling sand; the sampling spear is driven horizontally or sloping slightly upwards into the stockpile at the sampling point (see figure C.3, arrangement b).

C.3 Sampling stockpiles of coarse aggregates by hand

When sampling a stockpile of coarse aggregate in deciding where to take the sampling increments the way the stockpile was built and the resulting segregation are considered. An example of the segregation in a stockpile built by allowing material to fall from the end of a fixed conveyor is shown in figure C.4. The sampling should be done according to the actual segregation.

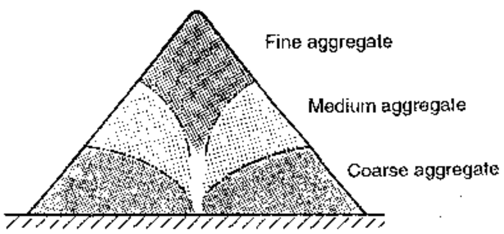

Figure C.4 Schematic composition of a cone-shaped stockpile of segregated aggregates

Annex D (informative)

The use of random numbers for random selection

D.1 General principles

A random sample of n elements are taken from a batch which consists of N elements.

The elements of the batch are numbered with 1, 2, ..., N.

If N consists of K figures, K-digit random numbers are taken from table D.1.

An arbitrary starting figure is chosen in table D.1.

A series of K-digit random numbers is read from left to right, beginning with the starting figure.

A K-digit number is disregarded, if there is no element with this number.

A K-digit number is disregarded if this number is already noted.

The elements with the first n numbers not disregarded are all sampled.

D.2 Example for the use of random numbers for random selection

n = 7 bags are chosen at random out of a palette of 70 bags.

The bags are numbered with 1, 2, ..., 70.

N = 70 has K = 2 figures; hence 2-digit numbers are taken from table D.1.

The arbitrary starting figure could be e.g. the figure 9 in the 14th row and the 31st column of table D.1.

Starting from this figure the following 2-digit numbers are read from left to right:

(93)	(00)	57	(00)
29	49	(73)	56
66	65	(89)	(80)
[49]	(77)	45	{73...}

The numbers 93, 00, 73, 89, 80 and 77 in round brackets are disregarded, because there are no bags with such numbers.

The number 49 in square brackets is disregarded because already noted before.

The seven bags with numbers 57, 29, 49, 56, 66, 65 and 45 are chosen as the sample.

(The numbers in tailed brackets starting with 73 are disregarded because already n = 7 bags are chosen).

Table D.1 Random numbers

row	**column**																							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
1	5	7	2	2	4	5	0	3	0	7	8	9	1	7	0	6	6	7	2	3	5	5	1	9	2
2	1	1	8	8	2	3	6	1	4	8	9	9	2	0	7	0	4	7	9	5	8	2	2	9	6
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5	7	7	0	7	5	8	0	1	7	9	3	6	9	9	5	9	5	5	4	6	0	1	2	1	1
6	7	2	6	2	6	7	9	2	7	2	0	7	5	8	1	1	8	2	7	5	3	4	2	1	5
7	9	7	2	9	9	0	6	3	2	1	4	5	8	6	9	9	8	9	8	5	5	9	4	7	4
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10	8	1	0	2	9	8	2	0	3	5	5	0	7	7	4	0	4	3	8	8	2	2	5	8	4
11	1	5	3	1	2	5	5	2	9	6	4	0	6	5	3	9	7	9	7	7	0	3	5	9	7
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14	1	3	5	9	9	7	2	6	5	7	0	6	9	4	1	7	0	0	4	9	6	4	7	1	2
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17	4	5	0	5	0	5	6	3	7	0	7	0	8	7	1	4	7	4	6	8	4	6	6	7	5
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	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
row	**column**																								

Table D.1 Random numbers (*concluded*)

row	column																								
	26	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
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16	0	7	1	7	0	1	0	9	7	5	1	3	7	5	5	0	3	8	5	3	2	1	1	1	8
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33	9	8	7	1	2	0	5	9	5	5	6	3	0	5	4	8	5	9	9	7	5	1	6	0	1
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45	4	1	1	5	8	8	7	4	8	8	8	9	5	8	7	0	1	8	8	8	9	1	8	7	5
46	7	2	1	4	3	4	1	1	8	8	5	4	9	8	0	5	3	0	8	5	3	3	2	4	6
47	3	0	1	6	8	2	3	7	5	8	4	4	4	8	1	8	8	6	7	4	7	0	2	0	9
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	26	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
row	**column**																								

Annex E (informative)
Bibliography

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List of references

See national foreword.

BSI — British Standards Institution

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