BRITISH STANDARD

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932-3 : 1997

Tests for general properties of aggregates

Part 3. Procedure and terminology for simplified petrographic description

The European Standard EN 932-3 : 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 Lighweight 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 Manufacturers' 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 January 1997

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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 932-3 : 1996 *Tests for general properties of aggregates — Part 3: Procedure and terminology for simplified petrographic description*, 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 the intention that this standard will be included in a 'package' of European Standards to be declared by CEN/TC 154. It does not replace any current British Standard.

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

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 6, an inside back cover and a back cover.

EUROPEAN STANDARD

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EN 932-3

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Descriptors: Aggregates, tests, characteristics, petrography, rocks, samples, nomenclature

English version

Tests for general properties of aggregates — Part 3: Procedure and terminology for simplified petrographic description

Essais pour déterminer les propriétés générales des granulats —
Partie 3: Procédure et terminologie pour la description pétrographique simplifiée

Prüfverfahren für allgemeine Eigenschaften von Gesteinskörnungen —
Teil 3: Durchführung und Terminologie einer vereinfachten petrographischen Beschreibung

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.

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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 932-3 : 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.

EN 932-1	*Tests for general properties of aggregates Part 1: Methods for sampling*
prEN 932-2	*Tests for general properties of aggregates Part 2: Methods for reducing laboratory samples*
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*

References specific to the petrographic examination are given in annex B (informative).

According to the 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 preparation.

1 Scope

This European Standard specifies a basic procedure for the petrographic examination of aggregates for the purposes of general classification. The procedure is not suitable for the detailed petrographical study of aggregates for specific end uses.

NOTE. The examination should be carried out by a qualified geologist (petrographer), with experience of materials used in civil engineering.

This European Standard covers only natural aggregates, sand and gravel or crushed rock aggregate as well as their source materials.

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 932-1 *Tests for general properties of aggregates — Part 1: Methods for sampling*

3 Definitions

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

NOTE. Rocks can be classified into three major divisions, according to their origin: igneous, sedimentary and metamorphic.

3.1 igneous rocks

Rocks formed from molten rock (magma) either at or below the earth's surface. Those formed below can be divided into two classes, plutonic and hypabyssal. Plutonic rocks are formed at depth in large bodies and typically have a coarse crystalline texture, with crystals clearly visible to the naked eye. Hypabyssal rocks are formed in smaller bodies near, but not at, the earth's surface and have a fine crystalline texture. Extrusive or volcanic rocks are formed as lavas and pyroclastics at the earth's surface and have a very fine or glassy texture.

3.2 sedimentary rocks

Rocks formed at the earth's surface by the accumulation, or precipitation, of the products of weathering and erosion of existing rocks. They can also be formed by the accumulation of organic debris. Such accumulated material can remain unconsolidated or it can be lithified into rock. Sedimentary rocks are usually layered.

3.3 metamorphic rocks

Rocks formed from pre-existing rocks by the action of heat and/or pressure in the earth's crust, which has caused mineralogical and structural transformations. Metamorphic rocks frequently have anisotropic texture.

4 Apparatus

4.1 *Handlens.*

4.2 *Pen knife.*

4.3 *Stereoscopic microscope*, (magnification: typically 10× to 100×).

4.4 *Polarizing microscope.*

4.5 *Reagent*, diluted hydrochloric acid.

5 Sampling

The sample to be examined can comprise material from drill cores, aggregate from stock piles, or the exposed faces of quarries. In order to ensure that the sample is representative, it shall be selected in accordance with a recognized sampling procedure.

In the case of a rock sample, the mass of material delivered for the examination shall be not less than 5 kg.

In the case of aggregates, the minimum sample mass Q delivered for examination depends on the largest particle size D, and shall be as given in table 1.

Table 1. Relationship between largest particle size D and minimum sample mass Q

Largest particle size D (mm)	**Minimum sample mass Q** (kg)
$31{,}5 < D \leqslant 63$	50
$16 < D \leqslant 31{,}5$	25
$8 < D \leqslant 16$	8
$4 < D \leqslant 8$	2
$\leqslant 4$	0,5

For aggregates, the sample used for the examination shall be taken in accordance with the procedures described in EN 932-1.

6 Description of a rock sample

6.1 Examination

The sample shall be first subjected to a visual examination to determine the constituent rock or mineral types. It may be appropriate to wash the sample.

Each rock type shall then be carefully inspected using a handlens or a stereoscopic microscope and other appropriate means.

NOTE 1. If necessary, where appropriate, thin sections should be examined using a polarizing microscope (more than one section can be necessary if the rock is coarse-grained or heterogeneous).

NOTE 2. Some physical properties, like density or ultrasonic pulse velocity, can also be usefully determined.

The description shall also include comments on the following:

a) grain size of the main constituents, texture, anisotropy, porosity, vesicularity (in volcanic rocks), colour;

b) mineralogical composition (quartz, feldspars, calcite, dolomite, etc.) and approximate determination of their respective proportions;

c) state of alteration and weathering.

NOTE 3. The description can also include comments on the presence, even in small quantities, of some constituents which can be of concern in particular circumstances (such as opal, micas or other phyllosilicates, sulfates, iron sulfides and organic materials).

6.2 Nomenclature

From the examination specified in **6.1**, assign, if possible, an appropriate name to the rock, preferably selected from the nomenclature given in annex A.

7 Description of an aggregate sample

7.1 General

Aggregates derived from natural deposits consist mainly of:

a) mineral particles; and

b) rock fragments.

The method of description and the nomenclature described in **7.2** and **7.3** shall be used only for particle sizes between 0,1 mm and 63 mm. It may be appropriate to wash the sample.

NOTE. The composition of aggregates often varies between size fractions. Hence, before carrying out the examination, it may be necessary to divide the aggregate into closely sized fractions which can be examined separately. The proportions of constituents can then be estimated by counting the particles in size fractions.

7.2 Examination

The description of the sample (or grain size fraction) shall include:

a) brief information about the shape, surface conditions (roughness etc.) and roundness of particles;

b) a petrographic identification based on counting a sufficiently representative number of particles.

Particles retained on a 4 mm sieve can be examined with the naked eye, or preferably with a handlens or stereoscopic microscope; the stereoscopic microscope shall be used for finer grains (in some cases, it may be necessary to use other methods such as thin sections for use with the polarizing microscope, or an acid test for the calcite identification, etc.).

The degree of weathering of the particles, and the presence of an exterior coating on the surface of the grains, shall be noted.

7.3 Description

7.3.1 Individual particles in an aggregate shall be described in the following terms:

7.3.1.1 *Rocks*, see annex A for the preferred nomenclature. In some cases, for a first description level, the classification can be simplified, for instance limited to : sedimentary (siliceous/carbonate rocks), plutonic, hypabyssal, volcanic, metamorphic.

7.3.1.2 *Minerals*, quartz, feldspars, micas, calcite, etc.

7.3.1.3 *Shell fragments.*

7.3.2 The aggregate as a whole shall be described as follows:

7.3.2.1 When a rock or mineral is predominant, (more than 50 %), its presence shall be reflected in the name of the material. For example:

a) quartzose sand (sand in which more than 50 % of the grains are quartz grains);

b) basaltic gravel (gravel in which more than 50 % of the particles consist of basalt fragments), etc.

7.3.2.2 When no single type is predominant, the material is said to be 'heterogeneous' and its name can include the most frequent type(s). For example:

a) heterogeneous quartzo-feldspathic sand;

b) heterogeneous siliceous gravel, etc.

8 Test report

The test report shall include.

8.1 Essential data needed to identify the sample.

8.2 The petrographic description of the different rock types (see **6.1**) or of the different aggregate size fractions (see **7.2**), including the results of any particle counting.

8.3 Geological information on source, i.e. on sample origin, as follows:

8.3.1 The type of formation, in the case of a sand and gravel deposit. The deposit shall be characterized as alluvium, beach deposit, slope scree, till, glaciofluvial deposit, etc.

In the case of the quaternary alluvial formations, the name of the corresponding river shall be given.

8.3.2 The geological age, in the case of sedimentary or volcanic formations, should be given if known, using one of the following terms.

Precambrian.

Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian.

Triassic, Jurassic, Cretaceous.

Tertiary.

Quaternary.

Annex A (informative)

Nomenclature

The following nomenclature is intended to provide a list of simple petrographic terms applicable to most types of rock used for aggregates. The definitions are given for information only.

A.1 Igneous rocks

A.1.1 *Plutonic igneous rocks*

A.1.1.1 *granite*, a light coloured rock containing alkali feldspars and quartz, together with mica (biotite and/or muscovite).

A.1.1.2 *syenite*, a light coloured rock, chemically intermediate between granite and gabbro, containing alkali feldspars (typically more than 60 %) and ferro-magnesian minerals (hornblende, biotite, etc.); a minor amount of nepheline or quartz, but not both, can be present.

A.1.1.3 *granodiorite*, a rock intermediate in composition between granite and diorite.

A.1.1.4 *diorite*, a rock chemically intermediate between granite and gabbro, containing plagioclase feldspar, hornblende and occasionally biotite and pyroxene; the quartz is normally lacking.

A.1.1.5 *gabbro*, a dark coloured rock containing calcium-rich feldspar and pyroxene, occasionally with olivine, biotite or hornblende.

A.1.2 *Hypabyssal igneous rocks*

Hypabyssal rocks are finer grained than their plutonic equivalents and are commonly distinguished by use of the prefix 'micro' before the appropriate plutonic rock name; hence the terms microgranite, microdiorite, etc. The two following terms are important exceptions as aggregates.

A.1.2.1 *dolerite*, a fine-grained equivalent of gabbro typically composed of calcium-rich feldspar, pyroxene and occasionally iron oxides: it is dark in colour and dense.

A.1.2.2 *diabase*, an altered dolerite in which the original minerals have been replaced by carbonate, albite, chlorite, serpentine, etc.[2)]

A.1.3 *Extrusive igneous rocks (volcanics)*

Volcanic rocks are not necessarily completely crystallized and can contain some amount of glass. The chemically equivalent plutonic rock is given for each type of volcanic rock.

A.1.3.1 *rhyolite*, a rock equivalent to granite and microgranite, usually consisting of quartz and alkali feldspar crystals in a glassy or cryptocrystalline groundmass.

A.1.3.2 *trachyte*, a usually light coloured equivalent of syenite.

A.1.3.3 *andesite*, a rock equivalent to diorite, usually with visible plagioclase and pyroxene crystals.

A.1.3.4 *dacite*, a rock equivalent of granodiorite.

A.1.3.5 *basalt*, a rock equivalent of gabbro and dolerite, very dark in colour, where pyroxene and olivine crystals can be apparent. Basaltlava is a term used in German to describe vesicular basalt.

NOTE 1. Tuff is an accumulation of fine grained, volcanic, fragmentary material, usually well indurated.

NOTE 2. Scoria is a term applied to rough, vesicular masses of lava or volcanic fragments. Example: scoriaceous basalt.

NOTE 3. Pumice is an extremely vesicular, glassy lava, usually of rhyolitic composition. It is often light enough to float on water.

NOTE 4. Volcanic breccia is a coherent rock formed by the brecciation and consolidation of lava by ongoing activity.

A.2 Sedimentary rocks

Consolidated[3)] sedimentary rocks can be divided into two groups based on their origin:

clastic rocks are essentially composed of detrital fragments derived from pre-existing rocks by physical weathering;

non-clastic, biogenic or chemical rocks are formed from the skeletons of organisms or by chemical solution and precipitation.

A.2.1 *Clastic rocks*

A.2.1.1 *sandstone*, a rock consisting mainly of detrital grains of quartz with a grain size between 63 mm and 2 mm, cemented by minerals like calcite, iron oxides, silica, some clay minerals, etc. Gritstone is a term used in the United Kingdom and Ireland for a coarse sandstone typically consisting of quartz grains coarser that 0,5 mm.

A.2.1.2 *conglomerate*, a rock composed of round detrital particles (rock fragments, quartz, etc.) which are predominantly larger than 2 mm, and cemented by silica, calcite, etc.

A.2.1.3 *breccia*, a conglomerate consisting of angular rock fragments.

A.2.1.4 *arkose*, a type of sandstone containing over 25 % of feldspar.

A.2.1.5 *greywacke*, an imprecisely defined type of well indurated, usually dark coloured sandstone, typically consisting of angular, sand sized particles of rock fragments, feldspar and quartz, together with some clayey matrix.

A.2.1.6 *quartzite*, a sandstone containing at least 90 % of quartz grains solidly cemented by silica, often referred to as orthoquartzite (as distinct from metaquartzite, the metamorphic equivalent).

[2)] The term is also used synonymously with dolerite in some countries but its use in this sense is not recommended.
[3)] Unconsolidated rocks, like sands, gravels, etc., are excluded.

A.2.1.7 *shale, siltstone*, argillaceous fine grained rocks.

A.2.2 *Chemical and biogenic rocks*

A.2.2.1 *limestone*, a rock consisting predominantly of calcium carbonate ($CaCO_3$).

A.2.2.2 *chalk*, a very fine grained Cretaceous limestone, usually white.

A.2.2.3 *dolomite*, a rock consisting predominantly of the mineral dolomite [$CaMg(CO_3)_2$].

A.2.2.4 *chert*, cryptocrystalline or microcrystalline silica, typically originating as nodules or layers in limestone. Flint is a chert originating in cretaceous chalk.

A.3 Metamorphic rocks

A.3.1 *amphibolite*, a rock composed mainly of hornblende, together with some feldspar and minor minerals, usually grey to dark green in colour.

A.3.2 *gneiss*, a widespread rock type with a characteristic banded or lenticular structure, consisting essentially of quartz, feldspar and mica, together with amphibole or pyroxene.

A.3.3 *granulite*, a fine grained rock containing quartz, feldspar, pyroxene (hypersthene) and garnet.

A.3.4 *hornfels*, a usually very hard rock produced by action of heat from an adjacent igneous magma, having equidimensional mineral grains without preferred orientation.

A.3.5 *calcitic/dolomitic marble*, a metamorphic limestone or dolomite in which the original minerals are completely recrystallized.

A.3.6 *quartzite*, a rock composed almost entirely of recrystallized quartz grains (i.e. metaquartzite).

A.3.7 *serpentinite*, a rock composed mainly of the mineral serpentine, typically dark green in colour with a low surface hardness.

A.3.8 *schist*, a widespread fine-to-medium-grained rock in which platelike or elongate minerals, such as micas or hornblende, are arranged in undulating subparallel layers, which confers a typical fissility to the rock.

A.3.9 *slate*, a fine-grained, homogeneous, argillaceous rock with characteristic perfect fissility.

A.3.10 *mylonite*, a metamorphic rock produced by shearing and granulation in a zone of intense faulting.

Annex B (informative) Bibliography

B.1 National standards

ASTM C 295	*Standard guide for petrographic examination of aggregate for concrete* (1990 edition).
ASTM C 294	*Standard descriptive nomenclature for constituents of natural mineral aggregates* (1986 edition).
BS 812 : Part 104 : 1994	*Testing aggregates Part 104. Method qualitative and quantitative petrographic examination of aggregates*
DIN 52100 –Part 2	*Natural stone and mineral aggregates; petrographical methods; general and summary* (1990 edition).
DS 405.1 : 1978	*Testing of sand, gravel and stone materials. Classification of natural aggregates.*
NF P 18-557	*Elements for identification of aggregates* (1990 edition).
SN 670 710 d	*Sand, gravel, chippings and crushed stone for road surfaces. Requirements and quality* (1988 edition).
UNI 8520 Part 4	*Aggregates for use in concretes — Petrographic examination* (1984 edition).

B.2 Other references

TP Min-StB Teil 1.2.1 *Specifications for test methods — Aggregates — Road construction Part 1.2.1: Petrographical nomenclature and quarries.* Research Society for Roads and Transport, 1986

Foucault A., Raoult J.F (1988): *Dictionnaire de Géologie — Masson — 3ème* édition 352 p.

Le Maitre (1989): *A classification of igneous rocks and glossary of terms. Recommendations of the IUGS Subcommission on the systematics of igneous rocks.* Blackwell Scientific Publications, Oxford, London.

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