INTERNATIONAL STANDARD

ISO 19595

First edition
2017-07

Natural aggregates for concrete

Granulats pour béton

Reference number
ISO 19595:2017(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 3, *Concrete production and execution of concrete structures*.

Natural aggregates for concrete

1 Scope

This document specifies the properties and requirements of aggregates obtained by processing natural materials and mixtures of these aggregates for use in concrete. It is applicable to aggregates with an oven-dried particle density greater than 2,00 Mg/m^3 (2 000 kg/m^3) in accordance with ISO 22965 (all parts).

This document incorporates a general requirement that natural aggregates are not intended to release any harmful substances in excess of the maximum permitted levels specified for the material or permitted in the national regulations of the place in use.

National provisions, preferably given in a national annex or a project specification, can specify additional or deviating requirements.

NOTE Requirements for the end use of aggregates in concrete are specified in ISO 22965 (all parts).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6274, *Concrete — Sieve analysis of aggregates*

ISO 6782, *Aggregates for concrete — Determination of bulk density*

ISO 6783, *Coarse aggregates for concrete — Determination of particle density and water absorption — Hydrostatic balance method*

ISO 7033, *Fine and coarse aggregates for concrete — Determination of the particle mass-per-volume and water absorption — Pycnometer method*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
aggregate
granular material of natural, manufactured or recycled origin used in construction

3.2
natural aggregate
aggregate from mineral sources which has been subjected to nothing more than mechanical processing, such as crushing, washing and sieving

3.3
aggregate size
designation of aggregate in terms of lower (d) and upper (D) sieve sizes expressed as d/D

Note 1 to entry: This designation accepts the presence of some particles which are retained on the upper sieve (oversize) and some which pass the lower sieve (undersize).

Note 2 to entry: Other designations may be used where specified in a national standard.

3.4
grading
particle size distribution expressed as the percentages by mass passing a specified set of sieves

3.5
fines
particle size fraction of an aggregate that passes the 0,063 mm sieve

Note 1 to entry: The 0,075 mm sieve may be used where specified in a national standard.

3.6
coarse aggregate
designation given to the larger aggregate sizes with D greater than 4 mm and d greater than or equal to 1 mm

Note 1 to entry: Aggregates that do not fit the definitions for fine or coarse (1 mm to 3 mm or 2 mm to 4 mm) are treated as coarse aggregate.

Note 2 to entry: Coarse aggregate may be separated by other sizes where specified in a national standard.

3.7
fine aggregate
designation given to the smaller aggregate sizes with D less than or equal to 4 mm and d = 0

Note 1 to entry: Fine aggregate can be produced from natural disintegration of rock or gravel and/or by the crushing of rock or gravel or processing of manufactured aggregates.

Note 2 to entry: Fine aggregate may be separated by other sizes where specified in a national standard.

3.8
all-in aggregate
aggregate consisting of a mixture of coarse and fine aggregates and fines with D greater than 4 mm and d = 0

Note 1 to entry: It can be produced without separating into coarse and fine fractions or it can be produced by combining coarse and fine aggregates.

3.9
filler aggregate
aggregate, most of which passes a 0,063 mm sieve, which can be added to construction materials to provide certain properties

Note 1 to entry: Other sieve sizes, as the 0,075 mm sieve, may be used where specified in a national standard.

3.10
declared value
value declared and documented by a manufacturer, which is derived from measured values under specified conditions and rules, for identification of performance requirements

4 Symbols and abbreviated terms

Symbol	Description
AAV	resistance to surface abrasion — aggregate abrasion value
AN	resistance to abrasion from studded tyres — Nordic abrasion value
AS	acid soluble sulfate content
F	resistance to freezing and thawing — percentage loss of mass
f	fines content
F_{EC}	resistance to freezing and thawing in the presence of salt (extreme conditions) — percentage loss of mass
FI	particle shape of coarse and all-in aggregates — flakiness index
LA	resistance to fragmentation — Los Angeles coefficient
MB	fines quality — methylene method
MD	resistance to wear — micro-Deval coefficient
MS	magnesium sulfate value
PSV	resistance to polishing of surface courses — polished stone value
S	total sulfur content
SC	shell content of coarse and all-in aggregates
SE	fines quality — sand equivalent method
SI	particle shape of coarse and all-in aggregates — shape index
SS	sodium sulfate value
SZ	resistance to fragmentation — impact value
WA	water absorption value after 24 h

5 Geometrical requirements

5.1 General

The necessity for testing and declaring all properties specified in this clause shall be limited according to the particular application at end use or origin of the aggregate. When required, the aggregates shall be tested as specified in this clause to determine the relevant geometrical properties.

NOTE Guidance on selection of appropriate categories for specific applications can be found in national provisions in the place of use of the aggregate.

5.2 Aggregate sizes

All aggregates shall be described in terms of aggregate sizes using the designations d/D and shall conform to the grading requirements specified in 5.3, except for aggregates added as fillers, which shall be specified as filler aggregate.

Aggregate sizes shall be specified using a pair of sieve sizes selected from one of the basic sets given in Table 1. The basic sets are based on the R 20 series in ISO 565.

Other sieves specified in national standards may be used.

Table 1 — Sieve sizes for specifying aggregate sizes

Basic set 1 mm	Basic set 2 mm	Basic set 3 mm	Basic set 4 mm
0	0	0	0
1	1	1	1,25 (1,2)
2	2	2	2,5
4	4	4	-
—	5,6 (5)	—	5,0
—	—	6,3 (6)	—
8	8	8	—
—	—	10	10
—	11,2 (11)	—	—
—	—	12,5 (12)	—
—	—	14	—
16	16	16	—
—	—	20	20
—	22,4 (22)	—	—
31,5 (32)	31,5 (32)	31,5 (32)	31,5 (30)
—	—	40	40
—	45	—	—
—	56	—	50
63 80 100	63 80 100	63 80 100	63 (60) 80 100
NOTE Rounded sizes shown in parentheses can be used as simplified descriptions of aggregate sizes.			

5.3 Grading

5.3.1 General

The grading of the aggregate shall be determined in accordance with ISO 6274 and shall conform to the requirements of 5.3.2 to 5.3.5 as appropriate to its aggregate size d/D.

Aggregates may comprise single sizes, all-in aggregates or combinations of two or more sizes.

Aggregates supplied as a mixture of different sizes or types should be uniformly blended. When aggregates of significantly different density are blended, caution is necessary to avoid segregation.

Where the specification requires the use of sieves which are a fraction of the upper sieve size (e.g. D/2 or D/1,4) the sieve chosen shall be the next nearest from basic set plus set 1 or basic set plus set 2.

NOTE When a sieve size of the ISO 565 R 20 series is closer to the calculated d/2, D/1,4 or D/2 size, the producer can choose to use this R 20 size.

5.3.2 Coarse aggregates

Coarse aggregates shall conform to the general requirements specified in Table 2, appropriate to their size designation D/d.

Table 2 — Overall limits and tolerances for coarse aggregate

Coarse aggregate			
Property	Requirement		
	Tolerance class 1	Tolerance Class 2	Tolerance Class 3
Particle distribution (grading): — percentage > d/2 — percentage > d — percentage > mid sieve, if D > 2d — percentage > D — percentage < 2D	 Declared value ± 7,0 % Declared value ± 5,0 % Declared value ± 20,0 % Declared value ± 15,0 % 100 %	 Declared value ± 5,0 % Declared value ± 10,0 % Declared value ± 15,0 % Declared value ± 10,0 % 100 %	 Declared value ± 3,0 % Declared value ± 7,0 % Declared value ± 12,0 % Declared value ± 7,0 % 100 %
Fines	Declared value ± 3,0 %	Declared value ± 2,0 %	Declared value ± 1,0 %
Particle density	Declared value ± 0,09 Mg/m^3	Declared value ± 0,07 Mg/m^3	Declared value ± 0,05 Mg/m^3
Water absorption	Declared value ± 0,5 %	Declared value ± 0,3 %	Declared value ± 0,2 %
Particle shape (flakiness index)	Declared value ± 9	Declared value ± 7	Declared value ± 5

5.3.3 Fine aggregates

Fine aggregates shall conform to the general requirements of Table 3, appropriate to their upper sieve size D.

National standards specifying other sieve sizes may be used where available.

NOTE Guidance on the description of coarseness/fineness of fine aggregates is given in Annex A.

Table 3 — Overall limits and tolerances for fine aggregate

Fine aggregate			
Property	Requirement		
	Tolerance class 1	Tolerance Class 2	Tolerance Class 3
Particle distribution (grading): — percentage > 0,125 mm — percentage > 0,5 mm — percentage > 2 mm — percentage > D	 Declared value ± 5,0 % Declared value ± 8,0 % Declared value ± 15,0 % Declared value ± 9,0 %	 Declared value ± 3,0 % Declared value ± 5,0 % Declared value ± 10,0 % Declared value ± 7,0 %	 Declared value ± 2,0 % Declared value ± 3,0 % Declared value ± 7,0 % Declared value ± 6,0 %
Fines	Declared value ± 5,0 %	Declared value ± 3,0 %	Declared value ± 2,0 %
Particle density	Declared value ± 0,05 Mg/m^3	Declared value ± 0,03 Mg/m^3	Declared value ± 0,02 Mg/m^3
Water absorption	Declared value ± 0,5 %	Declared value ± 0,3 %	Declared value ± 0,2 %

5.3.4 All-in aggregates

All-in aggregates shall conform to the general requirements of Table 4, appropriate to their upper sieve size D.

National Standards specifying other sieve sizes may be used where available.

Table 4 — Tolerances on declared typical grading for all-in aggregate

All-in aggregate			
Property	Requirement		
	Tolerance class 1	Tolerance Class 2	Tolerance Class 3
Particle distribution (grading): — percentage > 0,063 mm — percentage > 0,250 mm — percentage > D/2 — percentage > D — percentage < 2D	 Declared value ± 7,0 % Declared value ± 25,0 % Declared value ± 25,0 % Declared value ± 7,5 % 100 %	 Declared value ± 5,0 % Declared value ± 25,0 % Declared value ± 20,0 % Declared value ± 5,0 % 100 %	 Declared value ± 3,0 % Declared value ± 20,0 % Declared value ± 10,0 % Declared value ± 5,0 % 100 %
Fines	Declared value ± 3,0 %	Declared value ± 2,0 %	Declared value ± 1,0 %
Particle density	Declared value ± 0,09 Mg/m^3	Declared value ± 0,07 Mg/m^3	Declared value ± 0,05 Mg/m^3
Water absorption	Declared value ± 0,5 %	Declared value ± 0,3 %	Declared value ± 0,2 %
Particle shape (flakiness index)	Declared value ± 9	Declared value ± 7	Declared value ± 5

5.3.5 Special use aggregates and declared grading categories

When special aggregates gradings are required for a particular end use, or to define a specific source, special grading envelopes shall be defined using the appropriate sieves from Table 1. The general principles of this clause shall be applied using appropriate requirements at 2D, 1,4D, D, d, d/2. The aggregate shall conform to the grading requirements specified.

NOTE This recognizes that size designations and grading categories are essentially categories of convenience and different sizes and grading categories can be used by agreement between supplier and purchaser.

5.3.6 Grading for filler aggregate

The grading shall conform to the values specified in Table 5.

National Standards specifying other sieve sizes may be used where available.

Table 5 — Grading requirements for filler aggregate

Sieve size mm	Percentage passing by mass	
	Overall range for individual results	Producer's maximum declared range[a]
2	100	
0,125	85 to 100	10
0,063	70 to 100	10

[a] Declared grading range on the basis of the last 20 values. 90 % of the results shall be within this range, but all the results shall be within the overall grading range.

5.3.7 Natural graded 0/8 mm aggregates

Natural graded 0/8 mm aggregates shall conform to the general requirements specified in Table 6.

National Standards specifying other sieve sizes may be used where available.

Table 6 — Grading requirements for 0/8 mm natural graded aggregates

Natural graded aggregate (d = 0 mm and D < 8 mm)			
Property	**Requirement**		
	Tolerance class 1	**Tolerance Class 2**	**Tolerance Class 3**
Particle distribution (grading): — percentage > 0,125 mm — percentage > 0,250 mm — percentage > 2 mm — percentage > D	 Declared value ± 50 % Declared value ± 8,0 % Declared value ± 15,0 % Declared value ± 9 %	 Declared value ± 3,0 % Declared value ± 5,0 % Declared value ± 10,0 % Declared value ± 7,0 %	 Declared value ± 2,0 % Declared value ± 3,0 % Declared value ± 7,0 % Declared value ± 6,0 %
Fines	Declared value ± 5,0 %	Declared value ± 3,0 %	Declared value ± 2,0 %
Particle density	Declared value ± 0,05 Mg/m^3	Declared value ± 0,03 Mg/m^3	Declared value ± 0,02 Mg/m^3
Water absorption	Declared value ± 0,5 %	Declared value ± 0,3 %	Declared value ± 0,2 %

5.4 Fines content

When required, the fines content shall be determined and the results declared using the designation f_{Declared}.

5.5 Fines quality

When required, the fines quality shall be determined in accordance with EN 933-8 or EN 933-9 and evaluated and declared as follows.

When the fines content in the fine aggregate is not greater than 3 %, or any other value according to the provisions valid in the place of use of the aggregate, no further testing is required.

If the fines content is greater than 3 %, the fines of fine aggregate shall be considered non-harmful (e.g. swelling of clay) when one of the two following conditions applies:

a) The sand equivalent value (*SE*), when tested in accordance with EN 933-8, and declared value SE_{Declared} is higher than a specified limit;

b) The methylene blue value (*MB*) on the 0/2 mm fraction, when tested in accordance with EN 933-9, and declared value MB_{Declared} is lower than a specified limit.

The compliance requirements for the sand equivalent test and the methylene blue test should normally be expressed with a probability of 90 %.

NOTE If the fines content is greater than 3 % by mass and there is documented evidence of satisfactory use, further testing might not be necessary.

5.6 Particle shape of coarse and all-in aggregates — Flakiness index and shape index

When required, the shape shall be determined in accordance with EN 933-3 in terms of the flakiness index, and the results declared using the designation FI_{Declared}.

The flakiness index shall be the reference test for the determination of the shape.

For all-in aggregates the flakiness index shall be measured on the fraction 4/D.

When required, the shape index shall be determined in accordance with EN 933-4 and the results declared using the designation SI_{Declared}.

5.7 Shell content of coarse and all-in aggregates

When required, the shell content of coarse and all-in aggregates shall be determined in accordance with EN 933-7 and the results declared using the designation SC_{Declared}.

For all-in aggregates the shell content has to be measured on the fraction 4/D.

6 Physical requirements

6.1 General

The necessity for testing and declaring all properties specified in this clause shall be limited according to the particular application at end use or origin of the aggregate. When required, the aggregates shall be tested as specified in this clause to determine the relevant physical properties.

6.2 Resistance to fragmentation

When required, the resistance to fragmentation shall be determined in accordance with EN 1097-2 in terms of the Los Angeles coefficient. The Los Angeles test method shall be the reference test for the determination of resistance to fragmentation. For all-in aggregates the test shall be carried out on the coarse aggregate fraction The Los Angeles coefficient shall be using the designation LA_{Declared}.

When required, the impact value shall be determined and the results declared using the designation SZ_{Declared}.

6.3 Resistance to wear

When required, the resistance to wear [micro-Deval coefficient (MD)] shall be determined in accordance with EN 1097-1 and the results declared using the designation MD_{Declared}.

6.4 Particle density and water absorption

6.4.1 Particle density

When required, the particle density shall be determined in accordance with ISO 6783 or ISO 7033 (apparent particle density) and the results declared.

6.4.2 Water absorption

When required, the water absorption shall be determined in accordance with ISO 6783 or ISO 7033 depending upon the size of the aggregate, and the results declared.

6.5 Bulk density

When required, the bulk density shall be determined in accordance with ISO 6782 and the results declared.

6.6 Resistance to polishing for surface courses

When required, the resistance to polishing for surface course aggregate [polished stone value (PSV)] shall be determined in accordance with EN 1097-8 and the results declared using the designation PSV_{Declared}.

6.7 Resistance to surface abrasion

When required, the resistance to surface abrasion [aggregate abrasion value (*AAV*)] shall be determined in accordance with EN 1097-8 and the results declared using the designation AAV_{Declared}.

6.8 Resistance to abrasion from studded tyres to be used for surface courses

When required, the resistance to abrasion from studded tyres [Nordic abrasion value (*AN*)] shall be determined in accordance with EN 1097-9 and the results declared using the designation AN_{Declared}.

7 Chemical requirements

7.1 General

The necessity for testing and declaring all properties specified in this clause shall be limited according to the particular application at end use or origin of the aggregate. When required, the aggregates shall be tested in accordance with EN 1744-1 as specified in this clause to determine the relevant chemical properties.

When the value of a property is required but not defined by specified limits, the value should be declared as an XX_{Declared} category, e.g. a value of say 1,2 % by mass for the acid-soluble sulfate content of air-cooled blast furnace slag corresponds to $AS_{1,2}$ (declared value).

NOTE 1 Guidance on selection of appropriate values for specific applications can be found in provisions in the place of use of the aggregate.

NOTE 2 Guidance on the effects of chemical constituents in aggregates, including alkali-silica reactivity and lightweight organic contaminators related to the durability and surface properties of the concrete in which they are incorporated, is given in Annex B.

7.2 Petrographic description

When required, the petrographic description of the aggregate shall be determined in accordance with EN 932-3 and described.

7.3 Sulfur containing compounds

7.3.1 Acid-soluble sulfate

When required, the acid-soluble sulfate content of the aggregates for concrete shall be determined and the results declared in accordance with the relevant category specified in Table 7.

Table 7 — Categories for maximum values of acid-soluble sulfate content

Aggregate	Acid soluble sulfate content Percentage by mass	Category *AS*
Natural aggregates	≤0,2	$AS_{0,2}$
	0,2 > AS ≤ 0,8	$AS_{0,8}$
	>0,8	AS_{Declared}
	No requirement	AS_{NR}

7.3.2 Total sulfur

When required, the total sulfur content shall be determined and the results declared in accordance with the relevant category specified in Table 8.

Table 8 — Categories for maximum values of total sulfur content

Aggregate	Total sulfur content %	Category S
Natural aggregates	≤1	S_1
	>1	$S_{Declared}$
	No requirement	S_{NR}

Special precautions are necessary if pyrrhotite, an unstable form of iron sulfide (FeS), is present in the aggregate. If this mineral is known to be present, a maximum total sulfur content of 0,1 % as S shall apply.

7.4 Chlorides

When required, the water-soluble chloride ion content of aggregates for concrete shall be determined and the results declared.

NOTE If the water-soluble chloride ion content of the combined aggregates is known to be 0,01 % or lower (e.g. for aggregates extracted from most inland quarries), this value can be used in the calculation of the chloride content of concrete.

7.5 Constituents which alter the rate of setting and hardening of concrete

When required, the presence of organic matter shall be determined (presence of humus test). If the results indicate the presence of high humic acid, the presence of fulvo acids shall be determined. If the supernatant liquid in these tests is lighter than the standard colours, the aggregates should be considered to be free from organic matter.

NOTE 1 Some inorganic compounds which discolour the supernatant liquid in the sodium hydroxide test do not adversely affect the setting and hardening of concrete.

Sugars do not affect the colour of the supernatant liquid in the humus content test or the fulvo acid test. If it is suspected that sugars or sugar type materials are present, the aggregate should be tested using the mortar test. The stiffening time and compressive strength requirements shown in a) and/or b) should apply.

Fine aggregates and filler aggregates that contain organic or other substances in proportions that alter the rate of setting and hardening of concrete shall be assessed for the effect on stiffening time and compressive strength.

The proportions of such materials shall be such that they do not

a) increase the stiffening time of mortar test specimens by more than 120 min, and/or

b) decrease the compressive strength of mortar test specimens by more than 20 % at 28 days.

When required, the presence of lightweight organic contaminators shall be tested and the results declared.

Two screening tests for the presence of organic matter are in common use:

— sodium hydroxide test;

— fulvo acid test.

Both tests may be applied to recycled aggregates. If the supernatant liquid in these tests is lighter than the standard colours, the aggregates may be considered to be free from organic matter.

Sugars do not affect the colour of the supernatant liquid in the sodium hydroxide or the fulvo acid test. If it is suspected that sugars or sugar type materials are present, the aggregate should be tested using the water extract test. The requirements for the influence on setting time shown in a) and/or b) should apply.

8 Durability

8.1 General

The necessity for testing and declaring all properties specified in this clause shall be limited according to the particular application at end use or origin of the aggregate. When required, the aggregates shall be tested as specified in this clause to determine the relevant durability properties.

8.2 Soundness of coarse aggregates

When required, the resistance to weathering of coarse aggregates shall be determined in accordance with EN 1367-2 or ASTM C88 the magnesium sulfate soundness test or the sodium sulfate test using five cycles, and the results shall be declared in accordance with the relevant category specified in Table 9.

Table 9 — Categories for maximum sulfate soundness

Magnesium sulfate value (*MS*) Percentage loss of mass	**Sodium sulfate value (*SS*)** Percentage loss of mass	**Category** *MS* **or** *SS*
≤10	≤5	MS_{10} or SS_{5}
≤15	≤10	MS_{15} or SS_{10}
≤20	≤15	MS_{20} or SS_{15}
≤30	≤20	MS_{30} or SS_{20}
>30	>20	MS_{Declared} or SS_{Declared}
No requirement	No requirement	MS_{NR} or SS_{NR}

Calculate the sulfate value (*MS* or *SS*) in percentage by mass for each of the two test specimens in accordance with Formula (1), recording each value to the first decimal place.

$$MS/SS = 100(M1 - M2) / M1 \qquad (1)$$

where

$M1$ is the initial mass of the test specimen, to the nearest ±0,1 g;

$M2$ is the final mass of aggregate retained on the 10 mm sieve, to the nearest ±0,1 g.

Calculate and record the mean of the two results obtained to the nearest whole number.

8.3 Freeze-thaw resistance

8.3.1 Water absorption as a screening test for freeze-thaw resistance

When required, the water absorption value as a screening test shall be determined in accordance and the result declared.

If the water absorption determined is not greater than the value selected as one of the categories specified in Table 10, the aggregate shall be assumed to be freeze-thaw resistant.

NOTE With some aggregate sources containing a proportion of microporous flint aggregates, the differentiation between satisfactory and unsatisfactory freeze-thaw durability can be better assessed by density measurements rather than water absorption.

Table 10 — Categories for maximum values of water absorption after 24 hours

Water absorption Percentage by mass	**Category** *WA*
≤1	WA_1
≤2	WA_2
>2	WA_{Declared}
NOTE The water absorption test is not applicable to blast furnace slag and unaltered porous basalt.	

8.3.2 Resistance to freezing and thawing

When required, the resistance to freezing and thawing shall be determined in accordance with EN 1376-1 and the results declared in accordance with the relevant category specified in Table 11.

Table 11 — Categories for maximum freeze-thaw resistance values

Freeze-thaw Percentage loss of mass	**Category** *F*
≤1	F_1
≤2	F_2
≤4	F_4
>4	F_{Declared}
No requirement	F_{NR}

Calculate the undersize by combining the residues from the three specimens, weigh and express the mass obtained as a percentage of the mass of the combined test specimens.

Calculate the freeze-thaw test (F) in percentage in accordance with Formula (2):

$$F = 100(M1 - M2) / M1 \tag{2}$$

where

$M1$ is the initial dry total mass of the three test specimens, in g;

$M2$ is the final dry total mass of the three test specimens, that is retained on the specified sieve, in g.

8.3.3 Resistance to freezing and thawing in the presence of salt (extreme conditions)

When required (see NOTE 1), the resistance to freezing and thawing shall be determined and the results shall be declared in accordance with the relevant category specified in Table 12. In this case, the resistance to freezing and thawing (8.3.2) shall not be determined.

NOTE 1 The results of this test provide a means for assessing an aggregate’s resistance to frost weathering in areas where frequent freeze-thaw cycling occurs with seawater sprays or abundant de-icing conditions and where result values of normal test methods do not describe correctly aggregate performance in extreme conditions.

NOTE 2 This test has been found to be appropriate for certain petrographic types of aggregate (e.g. basalts) under severe conditions of use and might not be universally applicable to all rock types.

Table 12 — Categories for maximum freeze-thaw resistance in the presence of salt

Freeze-thaw Percentage loss of mass	**Category** F_{EC}
≤2	$F_{EC,2}$
≤4	$F_{EC,4}$
≤5	$F_{EC,5}$
≤6	$F_{EC,6}$
≤8	$F_{EC,8}$
≤14	$F_{EC,14}$
≤25	$F_{EC,25}$
≤50	$F_{EC,50}$
>50	$F_{EC,Declared}$
No requirement	$F_{EC,NR}$
NOTE When tested using de-icing solutions other than NaCl, the limits of Table 12 would not apply.	

Calculate the undersize by combining the residues from the three specimens, weigh and express the mass obtained as a percentage of the mass of the combined test specimens.

Calculate the freeze-thaw test (F_{EC}) in percentage in accordance with Formula (3):

$$F_{EC} = 100(M1 - M2) / M1 \tag{3}$$

where

M1 is the initial dry total mass of the three test specimens, in g;

M2 is the final dry total mass of the three test specimens, that is retained on the specified sieve, in g.

8.4 Volume stability — Drying shrinkage

Where disruptive shrinkage cracking of concrete might occur due to the properties of the aggregates, the drying shrinkage associated with aggregates to be used in structural concrete shall, when required, not exceed 0,075 % when tested in accordance with EN 1367-4 and the results declared.

NOTE This requirement does not apply to positions where drying out never occurs, mass concrete surfaced with air entrained concrete, or to structural elements symmetrically and heavily reinforced and not exposed to the weather.

8.5 Alkali-silica reactivity

When required, the alkali-silica reactivity of aggregates shall be assessed in accordance with the provisions valid in the place of use.

NOTE Guidance on the effects of alkali-silica reactivity is given in Annex B.

9 Evaluation of conformity

Requirements for evaluation of conformity may be given on a national level or established in agreement with an independent body certifying the production and the product. The requirement shall be available from the producer on request.

10 Designation

10.1 Designation and description

Aggregates shall be identified in the following terms:

a) source and producer (if the material has been re-handled in a depot, both source and depot shall be given);

b) type of aggregate;

c) aggregate size.

10.2 Additional information for the description of an aggregate

The necessity for other information depends on the situation and end use, for example:

a) a code to relate the designation to the description;

b) any other additional information needed to identify the particular aggregate.

The purchaser should inform the producer at the time of order of any special requirements associated with a particular end use and of requirements for extra information.

11 Marking and labelling

The delivery ticket shall contain at least the following information:

a) source and producer;

b) designation;

c) date of dispatch;

d) serial number of the ticket;

e) reference to this document, e.g. ISO 19595.

Annex A
(informative)

Guidance on the description of coarseness/fineness of fine aggregates

Tables A.1 and A.2 are provided where specifiers additionally describe the coarseness or fineness of fine aggregates, which are specified using sieve sizes of basic set 1, 2 and 3. Either of the tables, but not both, can be used for such descriptions.

In Tables A.1 and A.2, coarse graded fine aggregates are denoted by the letter *C*, medium grading by *M* and fine grading by *F*.

Additionally, when Table A.1 is selected, a P for percentage passing the 0,500 mm sieve is added after *C*, *M* or *F* (e.g. for medium grading, *MP*).

Similarly, when Table A.2 is selected, an *F* for fineness modulus is added after *C*, *M* or *F* (e.g. for fine grading, *FF*).

Table A.1 — Coarseness or fineness based on the percentage passing the 0,500 mm sieve

Percentage passing by mass		
CP	***MP***	***FP***
5 to 45	30 to 70	55 to 100

Table A.2 — Coarseness or fineness based on the fineness modulus

Fineness modulus		
CF	***MF***	***FF***
4,0 to 2,4	2,8 to 1,5	2,1 to 0,6

Fineness modulus (*FM*) is used to check constancy. Where additionally required, the *FM* of a delivery should be within the limits of the declared *FM* ± 0,50 or other specified limit.

NOTE Fineness modulus (*FM*) is normally calculated as the sum of cumulative percentages by mass retained on the following sieves (mm) expressed as a percentage, i.e. in Formula (A.1):

$$\text{FM} = \frac{\Sigma\ \{(>4)+(>2)+(>1)+(>0{,}5)+(>0{,}25)+(>0{,}125)\}}{100} \tag{A.1}$$

Annex B
(informative)

Guidance on the effects of some chemical constituents of aggregates on the durability of concrete in which they are incorporated

B.1 Chlorides in natural aggregates

Chlorides can be present in aggregates, usually as sodium and potassium salts. The quantity present being largely dependent on the source of the aggregate. Such salts contribute to the total chloride and alkali content of the concrete. To minimize the risk of corrosion of embedded metal, it is usual to limit the total quantity of chloride ion contributed by all the constituent materials in the concrete.

The water-soluble chloride ion content of aggregates extracted from most inland deposits is likely to be very low. Where it can be shown that the chloride content of such materials is not greater than 0,01 %, this value can be used in the calculation procedure based on the maximum chloride contents of the constituent materials in the concrete.

B.2 Sulfates

Sulfates in aggregates can give rise to expansive disruption of the concrete. A substantial proportion of the sulfate in crystalline blast-furnace slag is encapsulated in the slag grains and therefore, plays no part in the hydration reactions of cement. For this reason, a higher proportion of sulfate is tolerable in slag. Under certain circumstances, other sulfur compounds present in the aggregates can oxidize in the concrete to produce sulfates. These can also give rise to expansive disruption of concrete.

B.3 Alkali-silica reaction with natural aggregates

Certain aggregates can react with alkaline hydroxides present in the pore fluids of concrete. Under adverse conditions and in the presence of moisture, this can lead to expansion and subsequent cracking or disruption of the concrete. The most common form of reaction occurs between alkalis and certain forms of silica (alkali-silica reaction). Another less common form of reaction is alkali-carbonate reaction.

In the absence of previous long-term experience of a lack of disruptive reactivity of a particular combination of cement and aggregate, it can be necessary to take one of the following precautions:

— limit the total alkali content of the concrete mix;

— use cement with low effective alkali content;

— use non-reactive aggregate combination;

— limit the degree of saturation of the concrete with water.

The combination of aggregates and cement can be assessed using regulations applicable at the place of use when compliance with one of the above procedures is not possible.

Where aggregates are imported across national boundaries, the purchaser should take account of experience in the country of origin.

B.4 Constituents affecting the surface finish of concrete

Where appearance is an essential feature of concrete, aggregates should not contain materials in proportions that adversely affect surface quality or durability.

NOTE Very small percentages by mass of contaminators in aggregates can have a considerable effect on concrete finishes, which can affect the suitability of a source for a particular end use.

The proportion of lightweight organic contaminators should not normally exceed

— 0,5 % by mass of fine aggregate, or

— 0,1 % by mass of coarse aggregate.

Where the surface of concrete is of importance, the proportion of lightweight organic contaminators should not normally exceed

— 0,25 % by mass of fine aggregate, or

— 0,05 % by mass of coarse aggregate.

In some situations, for example critical fair-faced concrete, it can be necessary to make additional agreements on levels of lightweight organic contaminators.

Some constituents of aggregates can adversely affect the surface finish of concrete causing staining, discoloration, swelling or pop-outs if present close to the surface of the concrete. Reactive iron sulfide and lignite are two examples of materials that can affect concrete in this way.

B.5 Constituents affecting the setting and hardening of concrete

Other constituents of aggregates can adversely affect the rate of hydration of cement altering the rate of setting and hardening of concrete. Humus and sugar-type materials are two examples of substances that have such an effect. Some clay minerals also adversely affect the rate of development of strength, the strength and the durability of concrete in which they are incorporated.

Bibliography

[1] ISO 565, *Test sieves — Metal wire cloth, perforated metal plate and electroformed sheet — Nominal sizes of openings*

[2] ISO 22965-1, *Concrete — Part 1: Methods of specifying and guidance for the specifier*

[3] ISO 22965-2, *Concrete — Part 2: Specification of constituent materials, production of concrete and compliance of concrete*

[4] EN 932-3, *Tests for general properties of aggregates — Part 3: Procedure and terminology for simplified petrographic description*

[5] EN 933-3, *Tests for geometrical properties of aggregates — Part 3: Determination of particle shape — Flakiness index*

[6] EN 933-4, *Tests for geometrical properties of aggregates — Part 4: Determination of particle shape — shape index*

[7] EN 933-7, *Tests for geometrical properties of aggregates — Part 7: Determination of shell content — Percentage of shells in coarse aggregate*

[8] EN 933-8, *Tests for geometrical properties of aggregates — Part 8: Assessment of fines — Sand equivalent method*

[9] EN 933-9, *Tests for geometrical properties of aggregates — Part 9: Assessment of fines — Methylene blue test*

[10] EN 1097-1, *Tests for mechanical and physical properties of aggregates — Part 1: Determination of the resistance to wear (micro-Deval)*

[11] EN 1097-2, *Tests for mechanical and physical properties of aggregates — Part 2: Methods for the resistance to fragmentation*

[12] EN 1097-8, *Tests for mechanical and physical properties of aggregates — Part 8: Determination of the polished stone value*

[13] EN 1097-9, *Tests for mechanical and physical properties of aggregates — Part 9: Determination of the resistance to wear by abrasion from studded tires — Nordic test*

[14] EN 1367-1, *Tests for thermal and weathering properties of aggregates — Part 1: Determination of resistance to freezing and thawing*

[15] EN 1367-2, *Tests for thermal and weathering properties of aggregates — Part 2: Magnesium sulfate test*

[16] EN 1367-4, *Tests for thermal and weathering properties of aggregates — Part 4: Determination of drying shrinkage*

[17] EN 1744-1, *Tests for chemical properties of aggregates — Part 1: Chemical analyses*

[18] ASTM C88, *Soundness of aggregates by use of sodium sulfate or magnesium sulfate*

ICS 91.100.30

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