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Tests for thermal and weathering properties of aggregates - Part 1: Determination of resistance to freezing and thawing

Prüfverfahren für thermische Eigenschaften und Verwitterungsbeständigkeit von Gesteinskörnungen - Teil 1: Bestimmung des Widerstands gegen Frost-Tau-Wechsel

Essais de détermination des propriétés thermiques et de l'altérabilité des granulats - Partie 1: Détermination de la résistance au gel-dégel

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This European Standard was approved by CEN on 12 February 2007.

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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 CEN Management Centre has the same status as the official versions.

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Contents

Page

Foreword

This document (EN 1367-1:2007) 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of an identical text or by endorsement, at the latest by September 2007, and conflicting national standards shall be withdrawn at the latest by September 2007.

This document supersedes EN 1367-1:1999.

This European Standard is one of a series of tests for thermal and weathering properties of aggregates as listed below:

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

EN 1367-3, *Tests for thermal and weathering properties of aggregates — Part 3: Boiling test for "Sonnenbrand basalt"*

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

EN 1367-5, *Tests for thermal and weathering properties of aggregates — Part 5: Determination of resistance to thermal shock*

prEN 1367-6, *Tests for thermal and weathering properties of aggregates – Part 6: Resistance to freezing and thawing in the presence of salt*

Test methods for other properties of aggregates will be covered by parts of the following European Standards:

EN 932, *Tests for general properties of aggregates*

EN 933, *Tests for geometrical properties of aggregates*

EN 1097, *Tests for mechanical and physical properties of aggregates*

EN 1744, *Tests for chemical properties of aggregates*

EN 13179, *Tests for filler aggregate used in bituminous mixtures*

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

1 Scope

This European Standard specifies a test method which provides information on how an aggregate behaves when it is subjected to the cyclic action of freezing and thawing.

NOTE The stresses on aggregates due to frost depend, amongst other factors, on the degree of water saturation as well as the rate of cooling.

The results provide a means for assessing an aggregate's resistance to this form of weathering.

The test is applicable to aggregates having a particle size between 4 mm and 63 mm.

2 Normative references

The following referenced documents are indispensable for the application 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.

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

EN 932-2, *Tests for general properties of aggregates — Part 2: Methods for reducing laboratory samples*

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

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

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

3 Terms and definitions

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

3.1
test specimen
sample used in a single determination when a test method requires more than one determination of a property

3.2
laboratory sample
reduced sample derived from a bulk sample for laboratory testing

3.3
constant mass
successive weightings after drying at least 1 h apart not differing by more than 0,1 %

NOTE In many cases constant mass can be achieved after a test portion has been dried for a pre-determined period in a specified oven at (110 ± 5) °C. Test laboratories can determine the time required to achieve constant mass for specific types and sizes of sample dependent upon the drying capacity of the oven used.

4 Principle

Test portions of single sized aggregates, having been soaked in water at atmospheric pressure, are subjected to 10 freeze-thaw cycles. This involves cooling to -17,5 °C under water and then thawing in a water bath at about 20 °C. After completion of the freeze-thaw cycles, the aggregates are examined for any changes (crack formation, loss in mass and, if appropriate, changes in strength).

The test method consists of soaking at atmospheric pressure and storage in water for thorough water absorption (see 8.1) and exposure to frost action under water (see 8.2).

5 Apparatus

5.1 All apparatus, unless otherwise stated, shall conform to the general requirements of EN 932-5.

5.2 Ventilated drying oven, with forced circulation of adequate capacity. The oven shall be capable of being controlled at (110 ± 5) °C.

5.3 Balance, with an accuracy of ± 0,1 g, of adequate capacity.

5.4 Low temperature cabinet, (upright or chest) with air circulation. The cabinet shall be automatically controlled to adhere to the temperature curve shown in Figure 1. The sample temperature in the thawing out phase can be controlled either by air circulation or immersion of sample cans in a 20 °C water bath. A manual method of control may be used, provided the correct cooling curve, as shown in Figure 1, is adhered to. In the case of a dispute, the automatic control shall be used.

5.5 Cans, made from seamless drawn or welded corrosion-resistant sheet metal, with a thickness of about 0,6 mm, having a nominal capacity of 2 000 ml, an internal diameter of 120 mm to 140 mm, and an internal height of 170 mm to 220 mm are suitable. Cans shall be covered by suitable lids.

For lightweight aggregates, cans shall be suitably ballasted.

5.6 Test sieves, conforming to EN 933-2.

5.7 Water, distilled or de-ionised.

6 Sampling

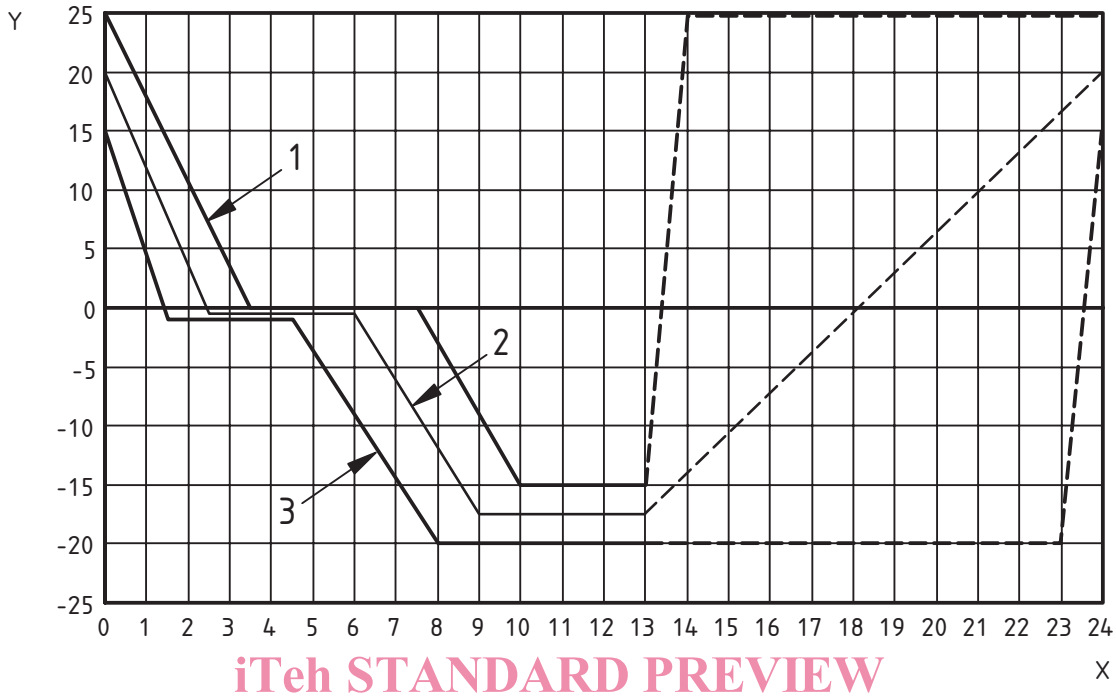
Sampling shall be carried out in accordance with EN 932-1.

7 Test specimens

7.1 General

Three individual test specimens shall be used. The test specimens shall be obtained in accordance with EN 932-2 by sample reduction from aggregates from which oversized and undersized fractions have been removed.

NOTE If it is intended to carry out a strength test after the freeze-thaw cyclic loading, this test should be performed on an appropriate grading sieved out from the laboratory sample, in accordance with Annex B.



Key

1 upper limit
2 control
3 lower limit
X time, in hours
Y temperature, in °C

Figure 1 — Temperature curve in the centre of the filled can (reference measuring point) located in the middle of the cabinet

7.2 Size of test specimens

The preferred size fraction shall be within the range 8 mm to 16 mm, but if required, any of the sizes listed in Table 1 may be used.

The quantities for each of the three individual test portions are specified in Table 1, and deviations of ± 5 % are permissible.

Table 1 — Mass of test portions required for the freeze-thaw cyclic test

Maximum aggregate size mm	Mass or volume of aggregate required	
	Normal aggregate g	Lightweight aggregate (bulk volume) ml
4 to 8	1 000	500
8 to 16	2 000	1 000
16 to 32	4 000 [a]	1 500
32 to 63	6 000 [a]	-
[a] Additional cans will be necessary.		

7.3 Preparation of test specimens

The test specimens shall be washed and adherent particles removed. They shall be dried to constant mass at (110 ± 5) °C, allowed to cool to ambient temperature and weighed immediately (M_1).

For lightweight aggregates, dry to constant mass.

Weighing shall be carried out to the following accuracies:

— aggregates up to 16 mm size, to ± 0,2 g;

— aggregates above 16 mm size, to ± 0,5 g.

8 Procedure

8.1 Soaking

The test specimens prepared in accordance with 7.3 shall be stored at atmospheric pressure for (24 ± 1) h in the cans specified in 5.5 at (20 ± 5) °C, in distilled or de-mineralized water, the water covering the test portions by at least 10 mm for the full 24 h period of soaking.

8.2 Exposure to freezing under water

Check that the water level in each can is still at least 10 mm above the top of the test specimen and place the lids on the cans. Place the covered cans containing the test specimens in the cabinet, ensuring that the distance between the cans and the sidewalls of the cabinet is not less than 50 mm and the cans are not touching, in order that the heat is extracted from them as uniformly as possible from all sides.