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Tests for thermal and weathering properties of aggregates - Part 2: Magnesium sulfate test

Prüfverfahren für thermische Eigenschaften und Verwitterungsbeständigkeit von Gesteinskörnungen - Teil 2: Magnesiumsulfat-Verfahren

Essais pour déterminer les propriétés thermiques et l'altérabilité des granulats - Partie 2 : Essai au sulfate de magnésium

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 1367-2:2009) 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of an identical text or by endorsement, at the latest by April 2010, and conflicting national standards shall be withdrawn at the latest by April 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1367-2:1998.

This European Standard is part of the EN 1367 series of European Standards under the general title: "Tests for thermal and weathering properties of aggregates". The other parts are:

Part 1: Determination of resistance to freezing and thawing;

Part 2: Magnesium sulfate test;

Part 3: Boiling test for “Sonnenbrand basalt”;

Part 4: Determination of drying shrinkage;

Part 5: Determination of resistance to thermal shock;

Part 6: Determination of resistance to freezing and thawing in the presence of salt (NaCl).

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 the United Kingdom.

1 Scope

This European Standard describes the reference method used for type testing and in cases of dispute for assessing how an aggregate behaves when subjected to the cyclic action of immersion in magnesium sulfate, followed by oven drying. For other purposes, in particular factory production control, other methods may be used provided that an appropriate working relationship with the reference method has been established.

NOTE The majority of aggregates can be tested for performance using this method. Precision has been established for the rock types listed in Annex A. The test may not be suitable for all rock types and reservations have been expressed elsewhere in respect of some carbonate aggregates and some aggregates having a high proportion of magnesium bearing materials or of cryptocrystalline quartz.

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 932-3, *Tests for general properties of aggregates – Part 3: Procedure and terminology for simplified petrographic description*

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*

ISO 649-1, *Laboratory glassware – Density hydrometers for general purposes – Part 1: Specification*

3 Terms and definitions

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

3.1
laboratory sample
sample intended for laboratory testing

3.2
test specimen
sample used in a single determination when a test method requires more than one determination of a property

3.3
test portion
sample used as a whole in a single test

4 Principle

Two test specimens of aggregate in the size range 10 mm to 14 mm are subjected to five cycles of immersion in a saturated solution of magnesium sulfate, followed by oven drying at (110 ± 5) ºC. This subjects the test specimens of aggregate to the disruptive effects of the repeated crystallization and rehydration of magnesium sulfate within the pores of the aggregate. The degradation arising from the disruptive effects is measured by the extent to which material finer than 10 mm in particle size is produced.

NOTE The procedure can also be applied to other aggregate fractions (Annex B) or combinations of fractions (Annex C).

5 Sampling

The laboratory sample to be used for the test shall be taken in accordance with EN 932-1.

6 Apparatus

Unless otherwise stated, all apparatus shall conform to the general requirements of EN 932-5.

6.1 *Test sieves,* conforming to EN 933-2, of 10 mm and 14 mm size.

6.2 *Balance,* of 2 kg capacity, accurate to 0,1 g.

6.3 *Brass or stainless steel mesh baskets,* at least two, for immersing test specimens in the solution. A suitable design is shown in Figure 1.

6.4 *Containers,* such that the baskets listed in 6.3 can be readily placed in and out, complying with the minimum separation clearances specified in 9.1, and with a volume at least five times the volume of the immersed aggregate.

6.5 *Tank or tank rooms,* capable of maintaining the temperature of the solution inside the containers at (20 ± 2) ºC during the immersion stages.

6.6 *Ventilated drying oven with forced air circulation*, of adequate capacity. The oven shall be capable of being controlled at (110 ± 5) ºC.

6.7 *Density hydrometer,* complying with ISO 649-1 and graduated at 20 ºC for medium surface tension 55 mN/m to measure densities in the range of 1,284 g/ml to 1,300 g/ml to an accuracy of 0,001 g/ml.

6.8 *Desiccator,* large enough to contain at least two of the baskets listed in 6.3.

6.9 *Thermometer,* of range 0 ºC to 120 ºC and accurate to 1 ºC.

6.10 *Timing device,* such that the full range of timed periods can be measured to an accuracy of ±1 min.

7 Reagents

7.1 *Distilled, or deionized water.*

7.2 *Barium chloride 5 % solution,* made by dissolving 5 g of barium chloride in 100 ml of distilled water.

7.3 *Saturated solution of magnesium sulfate,* which may be made by dissolving magnesium sulfate heptahydrate of reagent grade in distilled or deionized water.

7.3.1 Prepare the solution by slowly adding 1 500 g of the crystalline salt to each litre of water. A minimum of 3 l is required for each test.

NOTE It is advisable to prepare a second batch of solution using the above procedure as a reserve, in case of solution failure during the test procedure, see 9.3.

During preparation, maintain the temperature of the solution between 25 ºC and 30 ºC and stir thoroughly during the addition of the crystals. After preparation, lower the temperature to (20 ± 2) ºC, and maintain at this temperature for (48 ± 1) h.

7.3.2 Prior to use, check that the solution has achieved a density of (1,292 ± 0,008) g/ml by decanting a portion of the solution into a glass jar, measuring the density with the hydrometer, and returning the solution to the container.

8 Preparation of test specimens

8.1 Reduce the laboratory sample in accordance with EN 932-2 to produce two test specimens of sufficient mass such that each will produce a minimum of 500 g of the 10 mm to 14 mm size when processed as specified in 8.3.

NOTE Guidance on testing other fractions is given in Annex B and on testing all fractions in Annex C.

8.2 Dry each test specimen in the oven at (110 ± 5) ºC for (24 ± 1) h, and allow to cool in the desiccator to laboratory temperature.

8.3 Sieve each test specimen using the 10 mm and 14 mm sieves to reject oversize and undersize to give a mass of approximately 500 g each.

8.4 Wash each test specimen with distilled water until free from dust, allow to drain and dry in the oven as specified in 8.2.

8.5 Repeat the sieving as specified in 8.3, to ensure that only material in the 10 mm to 14 mm range is used.

8.6 Weigh out between (420 ± 0,1) g and (430 ± 0,1) g from each test specimen and record the masses (M_1). Transfer the test specimens to two labelled mesh baskets. Avoid shaking the baskets at all subsequent stages to minimize any loss by abrasion.

9 Procedure

9.1 Suspend each basket in a container holding the saturated magnesium sulfate solution at (20 ± 2) °C so that the top of the aggregate is completely immersed to a depth of 20 mm for a period of (17 ± 0,5) h. A minimum of 20 mm clearance shall be maintained between each basket, container sides and accumulated salt cakes.

Take particular care to ensure that no whole piece of aggregate is lost from any basket at any stage. Cover the container to avoid evaporation and contamination.

9.2 After immersion, remove each basket from the solution and drain for (2 ± 0,25) h then cover the container immediately. Dry each basket as in 8.2 and cool to laboratory temperature for (5 ± 0,25) h.

9.3 Prior to the next immersion, break up any salt cake which may have accumulated at the bottom of the container, stir the solution thoroughly and allow to settle for 30 min. Check the density of the solution in the container as specified in 7.3.2. If the density is outside the specified range, replace the solution with unused saturated solution as prepared in accordance with 7.3.1.

Where severe disintegration of aggregate occurs during immersion, the measured densities of the solution may be inaccurate due to suspended fines or ion-exchange effects. Under these circumstances, replace with unused solution.

9.4 Repeat the process specified in 9.1 to 9.3 for five cycles, each cycle taking (48 ± 2) h.

NOTE If it is necessary to interrupt the test, for example at weekends, it can be done at the end of the drying stage. The containers should be kept at laboratory temperature. A total interruption of up to 72 h is possible.

9.5 After cooling at the completion of the five cycles as specified in 9.2, wash the aggregate in each basket with tap water until the washings are free from magnesium sulfate.

NOTE This can be verified by testing a 10 ml aliquot of the washings with a few drops of barium chloride solution for turbidity, and comparing this with the turbidity of an equal volume of fresh tap water similarly treated.

9.6 Dry each test specimen as specified in 8.2. Hand sieve on the 10 mm sieve and record the mass (M_2) of the aggregate retained on the sieve to the nearest 0,1 g.

10 Calculation and expression of results

10.1 Calculate the magnesium sulfate value (*MS*) in percentage by mass for each test specimen in accordance with the following equation, recording each value to the first decimal place:

$$MS = 100\,\frac{(M_1 - M_2)}{M_1}$$

where:

M_1 is the initial mass of the test specimen, to the nearest ± 0,1 g;

M_2 is the final mass of aggregate retained on the 10 mm sieve, to the nearest ± 0,1 g.

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

11 Test report

The test report shall include the following information:

a) reference to this European Standard;

b) the magnesium sulfate value (*MS*) in accordance with 10.2;

c) the individual magnesium sulphate values of the two specimens (for each aggregate fraction tested);