SLOVENSKI STANDARD
SIST EN 1097-6:2013

01-oktober-2013

Nadomešča:
SIST EN 1097-6:2002
SIST EN 1097-6:2002/A1:2005
SIST EN 1097-6:2002/AC:2004

Preskusi mehanskih in fizikalnih lastnosti agregatov - 6. del: Določevanje prostorninske mase zrn in vpijanja vode

Tests for mechanical and physical properties of aggregates - Part 6: Determination of particle density and water absorption

Prüfverfahren für mechanische und physikalische Eigenschaften von Gesteinskörnungen - Teil 6: Bestimmung der Rohdichte und der Wasseraufnahme

Essais pour déterminer les caractéristiques mécaniques et physiques des granulats - Partie 6 : Détermination de la masse volumique réelle et du coefficient d'absorption d'eau

Ta slovenski standard je istoveten z: **EN 1097-6:2013**

ICS:

91.100.15	Mineralni materiali in izdelki	Mineral materials and products

SIST EN 1097-6:2013 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1097-6

July 2013

ICS 91.100.15

Supersedes EN 1097-6:2000

English Version

Tests for mechanical and physical properties of aggregates - Part 6: Determination of particle density and water absorption

Essais pour déterminer les caractéristiques mécaniques et physiques des granulats - Partie 6 : Détermination de la masse volumique réelle et du coefficient d'absorption d'eau

Prüfverfahren für mechanische und physikalische Eigenschaften von Gesteinskörnungen - Teil 6: Bestimmung der Rohdichte und der Wasseraufnahme

This European Standard was approved by CEN on 8 May 2013.

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

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

Page

Foreword

This document (EN 1097-6:2013) 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 January 2014, and conflicting national standards shall be withdrawn at the latest by January 2014.

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 1097-6:2000.

Annex J provides details of significant changes between this European Standard and the previous edition.

This standard forms a part of a series of tests for mechanical and physical properties of aggregates. Test methods for other properties of aggregates are covered by the following European Standards:

— EN 932 (all parts), *Tests for general properties of aggregates*

— EN 933 (all parts), *Tests for geometrical properties of aggregates*

— EN 1367 (all parts), *Tests for thermal and weathering properties of aggregates*

— EN 1744 (all parts), *Tests for chemical properties of aggregates*

— EN 13179 (all parts), *Tests for filler aggregate used in bituminous mixtures*

The other parts of EN 1097 include:

— *Part 1: Determination of the resistance to wear (micro-Deval)*

— *Part 2: Methods for the determination of resistance to fragmentation*

— *Part 3: Determination of loose bulk density and voids*

— *Part 4: Determination of the voids of dry compacted filler*

— *Part 5: Determination of the water content by drying in a ventilated oven*

— *Part 7: Determination of the particle density of filler — Pyknometer method*

— *Part 8: Determination of the polished stone value*

— *Part 9: Determination of the resistance to wear by abrasion from studded tyres — Nordic test*

— *Part 10: Determination of water suction height*

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece,

Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies the reference methods used for type testing and in case of dispute, for the determination of particle density and water absorption of normal weight and lightweight aggregates. Other methods may be used for other purposes, such as factory production control, provided that an appropriate working relationship with the reference method has been established. For convenience, some of these other methods are also described in this standard.

The reference methods for normal weight aggregates specified are:

— a wire basket method for aggregate particles retained on the 31,5 mm sieve (Clause 7, except for railway ballast which uses Annex B);

— a pyknometer method for aggregate particles passing the 31,5 mm test sieve and retained on the 4 mm test sieve (Clause 8);

— a pyknometer method for aggregate particles passing the 4 mm test sieve and retained on the 0,063 mm test sieve (Clause 9).

In Clauses 7, 8 and 9, three different particle density parameters (oven-dried particle density, saturated and surface dried particle density and apparent particle density) and water absorption are determined after a soaking period of 24 h. In Annex B, the oven-dried particle density parameter is determined after soaking in water to constant mass.

The wire basket method may be used as an alternative to the pyknometer method for aggregate particles passing the 31,5 mm test sieve and retained on the 4 mm test sieve. In case of dispute, the pyknometer method described in Clause 8 should be used as the reference method.

NOTE 1 The wire basket method can also be used for single aggregate particles retained on the 63 mm sieve.

NOTE 2 The pyknometer method described in Clause 8 can be used as an alternative for aggregates passing the 4 mm sieve but retained on the 2 mm sieve.

The reference method for lightweight aggregates (Annex C) is a pyknometer method for aggregate particles passing the 31,5 mm test sieve and retained on the 4 mm test sieve. Three different particle density parameters and water absorption are determined after pre-drying and a soaking period of 24 h.

Three other methods for normal weight aggregates can be used to determine the pre-dried particle density:

— a wire basket method for aggregate particles passing the 63 mm test sieve and retained on the 31,5 mm test sieve (A.3);

— a pyknometer method for aggregate particles passing the 31,5 mm test sieve and retained on the 0,063 mm test sieve (A.4);

— a pyknometer method for aggregate particles passing the 31,5 mm test sieve, including the 0/0,063 mm size fraction (Annex G).

NOTE 3 If water absorption is less than about 1,5 %, the apparent particle density can be assessed using the pre-dried particle density method as defined in Annex A.

The quick method in Annex E can be used in factory production control to determine the apparent particle density of lightweight aggregates.

Guidance on the significance and use of the various density and water absorption parameters is given in Annex H.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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*

3 Terms and definitions

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

3.1
apparent particle density

ρ_a

ratio obtained by dividing the oven-dried mass of an aggregate sample by the volume it occupies in water including the volume of any internal sealed voids but excluding the volume of water in any water accessible voids

Note 1 to entry: For lightweight aggregates the symbol ρ_{La} is used.

3.2
constant mass

mass determined after successive weighings at least 1 h apart not differing by more than 0,1 %

Note 1 to entry: 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 necessary to achieve constant mass for specific types and sizes of sample dependent upon the drying capacity of the oven used.

3.3
oven-dried particle density

ρ_{rd}

ratio obtained by dividing the oven-dried mass of an aggregate sample by the volume it occupies in water including the volume of any internal sealed voids and the volume of any water accessible voids

Note 1 to entry: For lightweight aggregates the symbol ρ_{Lrd} is used.

3.4
pre-dried particle density

ρ_p

ratio obtained by dividing the pre-dried mass of an aggregate sample by the volume it occupies in water including the volume of any internal sealed voids but excluding the volume of water in any water accessible voids

Note 1 to entry: Test conditions in terms of pre-drying of the test sample and the shorter immersion period differ from the ones for apparent particle density.

Note 2 to entry: Pre-dried particle density is a rapid test.

3.5
saturated and surface-dried particle density

ρ_{ssd}
ratio obtained by dividing the sum of the oven-dried mass of an aggregate sample and the mass of water in any water accessible voids by the volume it occupies in water including the volume of any internal sealed voids and the volume of any water accessible voids

Note 1 to entry: For lightweight aggregates the symbol ρ_{Lssd} is used.

3.6
test portion
sample used as a whole in a single test

3.7
test specimen
sample used in a single determination when a test method requires more than one determination of a property

3.8
water absorption
mass of absorbed water expressed as a percentage of the oven-dried mass of the aggregate sample

4 Principle

Particle density is calculated from the ratio of mass to volume. The mass is determined by weighing the test portion in the saturated and surface-dried condition and again in the oven-dried condition. Volume is determined from the mass of the water displaced, either by mass reduction in the wire basket method or by weighings in the pyknometer method.

Due to the influence on the absorption, no artificial heating of the test portion should be applied before testing. However, if such material is used, this fact should be stated in the test report.

For porous aggregates, the values of absorption and density depend on the size fractions which are tested. For this reason, the size fractions tested should be stated in the test report.

If the aggregate consists of a number of different size fractions, it may be necessary to separate the various fractions before preparing the test portion. The percentage of each size fraction shall be stated in the test report.

5 Materials

Water, boiled and cooled before use.

Fresh tap water and demineralised water are both suitable. The water should be free from any impurity (e.g. dissolved air) that could significantly affect its density. Dissolved air can also be removed by applying a vacuum.

6 Apparatus

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

6.1 Apparatus for general purposes.

6.1.1 Ventilated oven, thermostatically controlled to maintain a temperature of (110 ± 5) °C.

6.1.2 Balance, accurate to 0,1 % of the mass of the test portion and of sufficient capacity to enable the wire basket containing the sample to be suspended and weighed in water.

6.1.3 Water bath, thermostatically controlled, capable of being maintained at (22 ± 3) °C.

6.1.4 Thermometer, accurate to 0,1 °C.

6.1.5 Test sieves, 0,063 mm, 4 mm, 31,5 mm and 63 mm, with apertures as specified in EN 933-2.

6.1.6 Trays, which can be heated in a ventilated oven without change in mass.

6.1.7 Dry soft absorbent cloths.

6.1.8 Washing equipment.

6.1.9 Timer.

6.2 Special apparatus for the wire basket method (Clause 7, A.3 and Annex B).

6.2.1 Wire basket, or perforated container of suitable size to enable suspension from the balance. The basket or container shall be resistant to corrosion.

6.2.2 Watertight tank, containing water at (22 ± 3) °C in which the basket may be freely suspended with a minimum clearance of 50 mm between the basket and the sides of the tank.

NOTE A watertight tank can be used instead of a water bath specified in 6.1.3.

6.3 Special apparatus for pyknometer method for aggregate particles passing the 31,5 mm test sieve and retained on the 4 mm test sieve (Clause 8).

6.3.1 Pyknometer, consisting of a glass flask or other suitable vessel with volume between 1 000 ml and 5 000 ml, constant to 0,5 ml for the duration of the test.

The volume of the pyknometer should be chosen to suit the size of the test portion. It is recommended that the test portion occupies about half of the pyknometer volume. Two smaller pyknometers can be used instead of one large one, by summing the weighings before calculating the density of the aggregate.

6.4 Special apparatus for pyknometer method for aggregate particles passing the 4 mm test sieve and retained on the 0,063 mm test sieve (Clause 9).

6.4.1 Pyknometer, consisting of a glass flask or other suitable vessel with volume between 500 ml and 2 000 ml, constant to 0,5 ml for the duration of the test.

The volume of the pyknometer should be chosen to suit the size of the test portion. It is recommended that the test portion occupies about half of the pyknometer volume. Two smaller pyknometers can be used instead of one large one, by summing the weighings before calculating the density of the aggregate.

6.4.2 Metal mould, in the form of a frustum of a cone (40 ± 3) mm at the top, (90 ± 3) mm at the bottom and (75 ± 3) mm high. The metal shall have a minimum thickness of 0,8 mm.

6.4.3 Metal tamper, of mass (340 ± 15) g and having a flat circular tamping face of diameter (25 ± 3) mm, for use with the metal mould.

6.4.4 Funnel, plain glass (alternative to use of the metal mould and tamper).

6.4.5 Shallow tray, of non-water absorbing material having a plane bottom of area not less than 0,1 m² and an edge of not less than 50 mm in height.

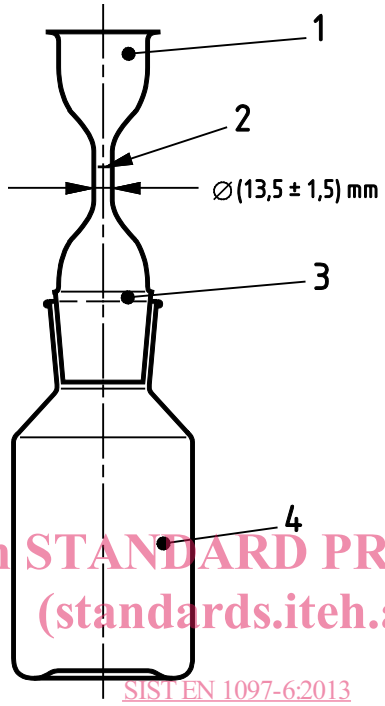
6.4.6 Warm air supply, such as a hair dryer.

6.5 Special apparatus for the pyknometer method for aggregate particles passing the 31,5 mm test sieve and retained on the 0,063 mm test sieve (A.4).

6.5.1 Pyknometer, consisting of a glass flask with a volume between 250 ml and 5000 ml, constant to 0,5 ml for the duration of the test, and a corresponding glass funnel.

Choose the pyknometer to suit the size of the test specimen. It is recommended that the test specimen occupies about half of the pyknometer volume.

NOTE An example of a suitable pyknometer is shown in Figure 1.



Key

1 glass funnel
2 mark
3 ground section to fit the wide-neck flat bottom flask
4 wide-neck flat bottom flask

Figure 1 — Example of pyknometer

6.6 Special apparatus for the determination of particle density and water absorption of coarse aggregates saturated to constant mass (Annex B).

6.6.1 Container, of similar capacity to the wire basket specified in 6.2.1 for storage of the sample in water.

6.7 Special apparatus for the determination of particle density and water absorption of lightweight aggregates (C.1).

6.7.1 Pyknometer, consisting of a glass flask with a volume between 1 000 ml and 2 000 ml and a corresponding funnel (Figure 1). If appropriate, the pyknometer shall contain a flexible grid to prevent aggregates from floating.

The size of the funnel should enable the release of any air bubbles.

The volume of the pyknometer should be chosen to suit the size of the test portion. It is recommended that the test portion occupies about half of the pyknometer volume.

6.8 Special apparatus for the determination of particle density of lightweight aggregates–with cylinder method (Annex E).

6.8.1 Glass graduated measuring cylinders, with a measuring volume of 1 000 ml.

6.8.2 Steel plunger (Figure 2), with a perforated base and vertical rod, to prevent aggregate particles from floating to the surface of the water. The difference between the internal diameter of the measuring cylinder and the diameter of the base shall be less than the smallest aggregate particles to be tested. The vertical rod of the plunger shall be marked so that volume it occupies in water is constant.

The dimensions of the holes in the perforated plate should be less than the smallest aggregate particles to be tested, but large enough to enable the release of entrapped air.

Figure 2 — Steel plunger with perforated plate

6.9 Special apparatus for the determination of the pre-dried particle density of aggregate passing the 31,5 mm test sieve (including the 0/0,063 mm size fraction) (Annex G).

6.9.1 Vacuum system, with a manometer or vacuum gauge, capable of evacuating air from the pyknometer to give a residual pressure of 4 kPa or less.

7 Wire basket method for aggregate particles passing the 63 mm test sieve and retained on the 31,5 mm test sieve

7.1 General

The wire basket method shall be used on aggregate particles passing the 63 mm test sieve and retained on the 31,5 mm test sieve. In the case of larger particles, reduce the particle size to pass the 63 mm sieve and to be retained on the 31,5 mm sieve.

NOTE A modified version of this method for determining the particle density and water absorption of coarse aggregates saturated to constant mass is given in Annex B.

7.2 Preparation of test portion

Sampling of the aggregates shall be in accordance with EN 932-1 and reduction shall be in accordance with EN 932-2. Wash the sample on the 63 mm sieve and the 31,5 mm sieve to remove finer particles. Discard any particles retained on the 63 mm sieve. Let the sample drain.

The mass of the test portion of aggregate shall be not less than the mass given in Table 1.

Table 1 — Minimum mass of test portions (wire basket method)

Upper (D) aggregate size	Minimum mass of test portions
mm	kg
63	15
≤ 45	7
For other sizes, the minimum mass of the test portion may be interpolated from the masses specified in Table 1.	

7.3 Test procedure

Place the prepared test portion in the wire basket and immerse it in the tank containing water at a temperature of (22 ± 3) °C, with a cover of at least 50 mm of water above the top of the basket.

Immediately after immersion, remove the entrapped air from the prepared test portion by lifting the basket about 25 mm above the base of the tank and letting it drop 25 times at about once per second.

Leave the basket and aggregate to remain completely immersed in the water at (22 ± 3) °C for a period of (24 ± 0,5) h.

Shake the basket and test portion and weigh them in water at a temperature of (22 ± 3) °C, M_2. Record the temperature of the water when M_2 was determined.

If it is necessary for the test portion to be transferred to a different tank for weighing, shake the basket and test portion 25 times as before in the new tank before weighing M_2.

Remove the basket and aggregate from the water and leave them to drain for a few minutes. Gently empty the aggregate from the basket on to one of the dry cloths. Return the empty basket to the water, shake it 25 times and weigh it in water, M_3.

Gently surface-dry the aggregate and transfer the aggregate to a second dry soft absorbent cloth when the first will remove no further moisture. Spread the aggregate out not more than one stone deep on the second sheet, and leave it exposed to the atmosphere away from direct sunlight or any other source of heat until all visible films of water are removed, but the aggregate still has a damp appearance. Weigh the aggregate, M_1.

Transfer the aggregate to a tray and place in the oven at a temperature of (110 ± 5) °C until it has reached constant mass. Let it cool to ambient temperature and weigh, M_4.

Record all masses to an accuracy of 0,1 % of the mass of the test portion, M_4, or better.

7.4 Calculation and expression of results

Calculate the particle densities (ρ_a, ρ_{rd} and ρ_{ssd}, as appropriate) in megagram per cubic metre in accordance with the following formulae:

apparent particle density

$$\rho_a = \rho_w \frac{M_4}{M_4 - (M_2 - M_3)} \quad (1)$$

oven-dried particle density

$$\rho_{rd} = \rho_w \frac{M_4}{M_1 - (M_2 - M_3)} \quad (2)$$

saturated and surface-dried particle density

$$\rho_{ssd} = \rho_w \frac{M_1}{M_1 - (M_2 - M_3)} \quad (3)$$

and the water absorption after immersion for 24 h, WA_{24}, in accordance with the following formula:

$$WA_{24} = \frac{100 \times (M_1 - M_4)}{M_4} \quad (4)$$

where

ρ_w is the density of water at the temperature recorded when M_2 was determined, in megagrams per cubic metre (see Annex D);

M_1 is the mass of the saturated and surface-dried aggregate in the air, in grams;

M_2 is the apparent mass in water of the basket containing the sample of saturated aggregate, in grams;

M_3 is the apparent mass in water of the empty basket, in grams;

M_4 is the mass of the oven-dried test portion in air, in grams.

Express the values of particle density to the nearest 0,01 Mg/m^3 and the water absorption to the nearest 0,1 %.

NOTE 1 The calculations can be checked using the following formula:

$$\rho_{ssd} = \rho_{rd} + \rho_w (1 - \rho_{rd} / \rho_a) \quad (5)$$

NOTE 2 An indication of precision is given in Annex I.

8 Pyknometer method for aggregate particles passing the 31,5 mm test sieve and retained on the 4 mm test sieve

8.1 General

The pyknometer method specified in this clause shall be used on aggregate particles passing the 31,5 mm test sieve and retained on the 4 mm test sieve.