



**SLOVENSKI STANDARD**  
**SIST EN 1097-6:2002**

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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

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EUROPEAN STANDARD

EN 1097-6

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## 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 18 August 2000.

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.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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## 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 December 2003, and conflicting national standards shall be withdrawn at the latest by December 2003.

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

This European Standard forms part of a series of tests for mechanical and physical properties of aggregates. 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 1367	Tests for thermal and weathering properties of aggregates
EN 1744	Tests for chemical properties of aggregates
EN 13179	Tests for filler aggregate used in bituminous mixtures

The other parts of EN 1097 will be:

- 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 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: Water suction height

## 1 Scope

This European Standard specifies methods for the determination of the particle density and water absorption of aggregates. The first five methods are applicable to normal aggregates with a sixth method for lightweight aggregates.

The principal methods specified are:

- a) a wire basket method for aggregates passing a 63 mm sieve but retained on a 31,5 mm sieve;
- b) pyknometer methods for aggregates passing a 31,5 mm sieve but retained on a 0,063 mm sieve.

NOTE 1 The wire basket method may be used as an alternative to the pyknometer method for aggregates between 4 mm and 31,5 mm. In case of dispute, the pyknometer method described in clause 8 should be used as the reference method.

NOTE 2 The wire basket method can also be used for single aggregate particles retained on a 63 mm sieve.

A method for the determination of pre-dried particle density of dense aggregates is specified in annex A.

NOTE 3 As the absorption of dense aggregates is low, pre-dried particle density can be determined directly in water. This method is different to the determination of particle density on an oven dried basis.

A modified version of the wire-basket method suitable for determining the particle density and water absorption of coarse aggregates saturated to constant mass is specified in annex B.

For lightweight aggregates, a modified version of the pyknometer test specified in annex A is specified in annex C.

## 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 (including amendments).

EN 932-1	<i>Tests for general properties of aggregates - Part 1: Methods for sampling</i>
EN 932-2	<i>Tests for general properties of aggregates - Part 2: Methods for reducing laboratory samples</i>
EN 932-5	<i>Tests for general properties of aggregates - Part 5: Common equipment and calibration</i>
EN 933-2	<i>Tests for geometrical properties of aggregates - Part 2: Determination of particle size distribution - Test sieves, nominal size of apertures</i>

### 3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply:

#### 3.1

##### **test portion**

sample used as a whole in a single test.

#### 3.2

##### **particle density on an oven dried basis**

ratio of the oven dried mass of a sample of aggregate to the volume it occupies in water including both internal sealed voids and water accessible voids.

#### 3.3

##### **apparent particle density**

ratio of the oven dried mass of a sample of aggregate to the volume it occupies in water including any internal sealed voids but excluding water accessible voids.

#### 3.4

##### **particle density on a saturated and surface-dried basis**

ratio of the combined mass of a sample of aggregate and the mass of water in the water accessible voids to the volume it occupies in water including both internal sealed voids and water accessible voids when present.

#### 3.5

##### **pre-dried particle density**

mass of dry particles per unit volume **(standards.iteh.ai)**

NOTE The volume is determined as the volume of the particles inclusive of both internal sealed voids and water accessible voids.

#### 3.6

##### **water absorption**

increase in mass of a sample of oven dried aggregate due to the penetration of water into the water accessible voids.

#### 3.7

##### **constant mass**

successive weighings 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  $(110 \pm 5) ^\circ\text{C}$ . 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

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 pycnometer method.

NOTE 1 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 report.

NOTE 2 For porous aggregates, the values of absorption and density depend on the size fractions which are tested. For this reason, the determined values are referenced to the size fractions actually tested.

If the aggregate consists of a number of different size fractions, it is necessary to separate the sample into fractions 0,063 mm to 4 mm, 4 mm to 31,5 mm and 31,5 mm to 63 mm, before preparing the test portion. The percentage of each fraction shall be stated in the test report.

## 5 Materials

Water, boiled and cooled before use.

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

## 6 Apparatus

### 6.1 General

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

### 6.2 Apparatus for general purposes (standards.iteh.ai)

6.2.1 **Ventilated oven**, thermostatically controlled to maintain a temperature of  $(110 \pm 5) ^\circ\text{C}$ .

6.2.2 **Balance**, accurate to 0,1 % of the mass of the test portion.

The capacity of the balance shall be suitable to allow the wire basket containing the sample to be suspended and weighed in water.

6.2.3 **Water bath**, thermostatically controlled, capable of being maintained at  $(22 \pm 3) ^\circ\text{C}$

6.2.4 **Thermometer**, accurate to 0,1  $^\circ\text{C}$ .

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

6.2.6 **Trays**, of suitable size which can be heated in a ventilated oven without change in mass.

6.2.7 **Dry soft absorbent cloths**

6.2.8 **Washing equipment**.

6.2.9 **Timer**.

### 6.3 Special apparatus for the wire-basket method (see clause 7, A.3, and B.2)

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

6.3.2 **Watertight tank**, containing water at  $(22 \pm 3) ^\circ\text{C}$  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 6.2.3.



**6.4 Special apparatus for pyknometer method for aggregate particles between 4 mm and 31,5 mm (see clause 8)**

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.

NOTE The required volume of the pyknometer should be chosen to suit the size of the test portion. Two smaller pyknometers can be used instead of one large one, by summing the weighings before the calculation is carried out.

**6.5 Special apparatus for pyknometer method for aggregate particles between 0,063 mm and 4 mm (See clause 9)**

**6.5.1 Pyknometer**, consisting of a glass flask or other suitable vessel with volume between 500 ml and 5000 ml, constant to 0,5 ml for the duration of the test.

NOTE The required volume of the pyknometer is to be chosen to suit the size of the test portion.

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

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

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

**6.5.5 Shallow tray**, of non-water absorbing material having a plane bottom of area not less than  $0,1 \text{ m}^2$  and an edge of not less than 50 mm in height.

**6.5.6 Warm air supply**, such as a hair dryer.

**6.6 Special apparatus for the pyknometer method for aggregate particles between 0,063 mm and 31,5 mm (see A.4)**

**Pyknometer**, consisting of a glass flask with a volume between 250 ml and 2 000 ml, constant to 0,5 ml for the duration of the test, and a corresponding glass funnel.

NOTE 1 The volume of the pyknometer is to be chosen to suit the size of the test specimen.

NOTE 2 An example of a suitable pyknometer is shown in Figure 1.

**6.7 Special apparatus for the determination of particle density and water absorption of coarse aggregates saturated to constant mass (see annex B)**

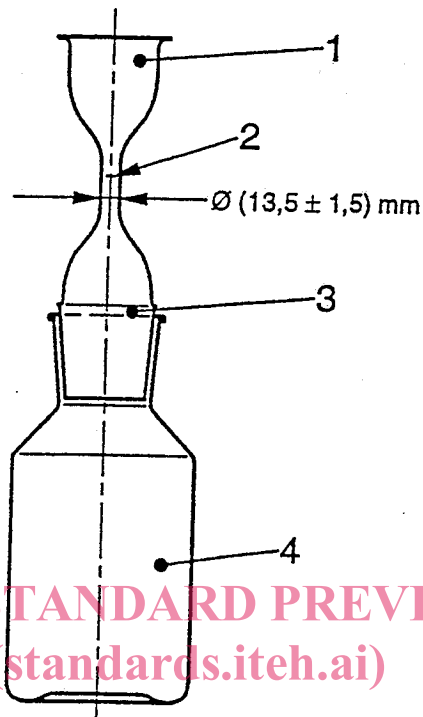
**Container**, of similar capacity to the wire basket specified in 6.3.1 for storage of the sample in water.

**6.8 Special apparatus for the determination of particle density and water absorption of pre-dried lightweight aggregates (See annex C)**

**Pyknometer**, consisting of a glass flask with a volume between 1 000 ml and 2 000 ml, constant to 0,5 ml for the duration of the test, and a corresponding glass funnel. If appropriate, the pyknometer shall contain a flexible grid to prevent aggregates floating,

NOTE 1 The volume of the pyknometer is to be chosen to suit the size of the test portion

NOTE 2 An example of a suitable pyknometer is given in Figure 1.



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#### 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

## 7 Wire-basket method for aggregate particles between 31,5 mm and 63 mm

### 7.1 General

The wire basket method shall be used on aggregate particles between 31,5 mm and 63 mm. In the case of pieces of rock, reduce the sample in 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. 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)**

Maximum size of aggregates mm	Minimum mass of test portions kg
63	15
45	7
NOTE For other sizes the minimum mass of the test portion may be interpolated from the masses specified in Table 1.	

Wash the test portion on the 63 mm sieve and the 31,5 mm sieve to remove finer particles and let the sample drain. Discard any particles retained on the 63 mm sieve.

## 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  $(22 \pm 3) ^\circ\text{C}$ , 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 allowing it to drop 25 times at about once per second.

Allow the basket and aggregate to remain completely immersed in the water at  $(22 \pm 3) ^\circ\text{C}$  for a period of  $(24 \pm 0,5)$  h.

Shake the basket and test portion and weigh them in water at a temperature of  $(22 \pm 3) ^\circ\text{C}$  ( $M_2$ ). Record the temperature of the water when mass ( $M_2$ ) was determined.

NOTE 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 allow 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  $(110 \pm 5) ^\circ\text{C}$  until it has reached constant mass ( $M_4$ ).

Record all weights 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 ( $\rho_a$ ,  $\rho_{rd}$ , and  $\rho_{ssd}$  as appropriate), in megagrams per cubic metre, in accordance with the following equations:

$$\text{Apparent particle density} \quad \rho_a = \rho_w \frac{M_4}{M_4 - (M_2 - M_3)}$$

$$\text{Particle density on an oven-dried basis} \quad \rho_{rd} = \rho_w \frac{M_4}{M_1 - (M_2 - M_3)}$$

$$\text{Particle density on a saturated and surface-dried basis} \quad \rho_{ssd} = \rho_w \frac{M_1}{M_1 - (M_2 - M_3)}$$

Calculate the water absorption (as a percentage of the dry mass) after immersion for 24 h ( $WA_{24}$ ) in accordance with the following numerical equation:

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

where:

- $M_1$  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;  
 $\rho_w$  is the density of water at the temperature recorded when  $M_2$  was determined, see annex D, in megagrams per cubic metre.

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

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

$$\rho_{ssd} = 1 + \rho_{rd} - \rho_{rd} / \rho_a$$

NOTE 2 An indication of precision is given in annex E.

## 8 Pycnometer method for aggregate particles between 4 mm and 31,5 mm

### 8.1 General

The pycnometer method specified in this clause shall be used on aggregate particles between 4 mm and 31,5 mm.

### 8.2 Preparation of test portion

Sampling of the aggregate shall be in accordance with EN 932-1 and reduction shall be in accordance with EN 932-2. The mass of the test portion of aggregate shall be not less than the mass given in Table 2.