

TÄITEMATERJALIDE MEHAANILISTE JA FÜÜSIKALISTE
OMADUSTE KATSETAMINE. OSA 6: TERADE TIHEDUSE
JA VEEIMAVUSE MÄÄRAMINE

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

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN 1097-6:2022 sisaldab Euroopa standardi EN 1097-6:2022 ingliskeelset teksti.	This Estonian standard EVS-EN 1097-6:2022 consists of the English text of the European standard EN 1097-6:2022.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation and Accreditation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 23.02.2022.	Date of Availability of the European standard is 23.02.2022.
Standard on kättesaadav Eesti Standardimis-ja Akrediteerimiskeskusest.	The standard is available from the Estonian Centre for Standardisation and Accreditation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 91.100.15

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardimis- ja Akrediteerimiskeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardimis- ja Akrediteerimiskeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardimis- ja Akrediteerimiskeskusega: Koduleht www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation and Accreditation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation and Accreditation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation and Accreditation:

Homepage www.evs.ee; phone +372 605 5050; e-mail info@evs.ee

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 et du coefficient
d'absorption d'eau

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

This European Standard was approved by CEN on 12 December 2021.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents	Page
European foreword	6
1 Scope	8
2 Normative references	9
3 Terms and definitions	9
4 Principle	11
5 Materials	11
6 Apparatus	11
7 Wire basket method for aggregate particles passing the 63 mm sieve and retained on the 31,5 mm sieve	15
7.1 General.....	15
7.2 Preparation of test portion.....	15
7.3 Test procedure.....	15
7.4 Calculation and expression of results.....	16
8 Pycnometer method for aggregate particles passing the 31,5 mm sieve and retained on the 4 mm sieve	17
8.1 General.....	17
8.2 Preparation of test portion.....	17
8.3 Test procedure.....	18
8.4 Calculation and expression of results.....	18
9 Pycnometer method for aggregate particles passing the 4 mm sieve and retained on the 0,063 mm sieve	19
9.1 General.....	19
9.2 Preparation of test portion.....	19
9.3 Test procedure.....	19
9.4 Calculation and expression of results.....	20
10 Test report	21
10.1 Required data	21
10.2 Optional data.....	22
Annex A (normative) Determination of pre-dried particle density of aggregates passing the 63 mm sieve (excluding the 0/0,063 mm size fraction)	23
A.1 General.....	23
A.2 Principle	23
A.3 Wire basket method for aggregate particles passing the 63 mm sieve and retained on the 31,5 mm sieve	23
A.3.1 Preparation of test portion.....	23
A.3.2 Test procedure.....	23
A.3.3 Calculation and expression of results.....	24

A.4	Pyknometer method for aggregate particles passing the 31,5 mm sieve and retained on the 0,063 mm sieve	24
A.4.1	Preparation of test specimens	24
A.4.2	Determination of the pyknometer volume	25
A.4.3	Test procedure	25
A.4.4	Calculation and expression of results	26
A.5	Test report	26
A.5.1	Required data.....	26
A.5.2	Optional data.....	27
Annex B (normative)	Determination of particle density and water absorption of coarse aggregates saturated to constant mass	28
B.1	General	28
B.2	Preparation of test portion	28
B.2.1	Sample reduction.....	28
B.2.2	Single particles of aggregate.....	28
B.2.3	Railway ballast.....	28
B.3	Test procedure	28
B.4	Calculation and expression of results	29
B.5	Test report	29
B.5.1	Required data.....	29
B.5.2	Optional data.....	30
Annex C (normative)	Determination of particle density and water absorption of coarse lightweight aggregates.....	31
C.1	General	31
C.2	Preparation of test specimens	31
C.3	Determination of the pyknometer volume	31
C.4	Test procedure	32
C.5	Calculation and expression of results	32
C.6	Test report	34
C.6.1	Required data.....	34
C.6.2	Optional data.....	34
Annex D (normative)	Determination of particle density and water absorption of fine lightweight aggregates.....	35
D.1	General	35
D.2	Principle.....	35
D.3	Preparation of test specimens	35
D.4	Test procedure	35
D.4.1	Water absorption.....	35

D.4.2	Particle density	36
D.5	Calculation and expression of results	36
D.5.1	Water absorption	36
D.5.2	Particle density	37
D.6	Test report	38
D.6.1	Required data	38
D.6.2	Optional data	38
Annex E	(normative) Quick method for determination of apparent particle density of coarse lightweight aggregates	39
E.1	General	39
E.2	Preparation of test specimens	39
E.3	Procedure	39
E.4	Calculation and expression of results	40
E.5	Test report	40
E.5.1	Required data	40
E.5.2	Optional data	40
Annex F	(informative) Determination of the particle density and water absorption of aggregates passing the 4 mm sieve	42
F.1	General	42
F.2	Preparation of test portion	42
F.3	Procedure	43
F.4	Calculation and expression of results	44
F.5	Test report	45
F.5.1	Required data	45
F.5.2	Optional data	45
Annex G	(normative) Density of water	46
Annex H	(normative) Determination of the pre-dried particle density of aggregates passing the 31,5 mm sieve	47
H.1	General	47
H.2	Principle	47
H.3	Preparation of test specimens	47
H.4	Test procedure	48
H.5	Determination of the pycnometer volume	48
H.6	Calculation and expression of results	49
H.7	Test report	49
H.7.1	Required data	49
H.7.2	Optional data	50

Annex I (informative) Guidance on the significance and use of various particle density parameters and water absorption	51
I.1 General	51
I.2 Characteristics of the reference methods for normal weight aggregates according to Clauses 7, 8 and 9 and Annex B.....	52
I.3 Characteristics of the reference method for coarse lightweight aggregates, specified in Annex C.....	53
I.4 Characteristics of the methods for determination of the pre-dried particle density of normal weight aggregates, specified in Annex A and Annex H.....	54
I.5 Selection of the appropriate particle density parameter	55
I.6 Applicability of and test conditions for the various test methods in EN 1097-6. 55	55
I.7 Relationships between different particle density parameters (notations according to the main methods, specified in Clauses 7, 8 and 9)	57
Annex J (informative) Precision	58
J.1 Data from National Standards.....	58
J.2 Data from cross testing experiments	59
Bibliography	61

European foreword

This document (EN 1097-6:2022) has been prepared by Technical Committee CEN/TC 154 “Aggregates”, the secretariat of which is held by BSI.

This document shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2022, and conflicting national standards shall be withdrawn at the latest by August 2022.

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

This document supersedes EN 1097-6:2013.

In comparison with the previous edition, the following technical modifications have been made:

- a) Normative references has been extended with EN 1097-5 (used in Annex D). EN 932-1 has been deleted from the clause since sampling is out of the scope, as for other standards;
- b) the definitions of laboratory sample and subsample have been added in Clause 3;
- c) the glass funnel in 6.4.4 has been deleted since it is part of the pyknometer in 6.5.1. The minimum volume of the pyknometer in 6.5.1 has been changed from 250 ml to 500 ml. New 6.8 and 6.10 have been added and describe special apparatus referenced in new Annexes D and F;
- d) Clause 9 has been extended with an illustration of the surface-dry state assessment using the cone test;
- e) the possibility to remove air from the pyknometer by applying a vacuum has been added in A.4.3;
- f) in Annex B, the test portion mass for single aggregates (B.2.2) and the temperature requirement in B.3 have been clarified. In addition, the time needed for achieving constant mass during suction has been clarified;
- g) the Note in C.1 has been revised to say that the method can also be used for aggregate particles passing the 4 mm sieve and retained on the 1 mm sieve. Soaking times for the water absorption determination have been added in C.1. A new paragraph has been added in C.1, saying that for concrete applications the water absorption of coarse lightweight aggregate shall be determined in the as-used moisture state instead of the oven-dry state. In C.4, a Note about using vibrating table as a vibration means has been added. Precision of individual values has been defined in C.5;
- h) a new normative Annex D has been designed to determine the particle density and water absorption of fine lightweight aggregates. Consequently, Annex C has been retitled to only apply to coarse lightweight aggregates;
- i) the title of Annex E has been shorted. The Note in E.1 has been revised to say that the method can also be used for aggregate particles passing the 2 mm sieve and retained on the 1 mm sieve. Precision of individual values has been defined in E.4;
- j) Annex F has been replaced by a new informative annex designed to determine the particle density and water absorption of aggregates passing the 4 mm sieve;

- k) the procedure in Annex H has been extended to specify double determination. In addition, the recommended volume which the test portion should occupy to enable the release of entrapped air, has been changed from one third to one half of the pycnometer volume, in consistency with other clauses;
- l) all annexes have been reordered to collect the annexes about lightweight aggregates. Annex D Density of water has been moved to Annex G and Annex J List of main changes has been deleted.

Furthermore, the whole standard has been updated according to the current rules and to reflect the changes. The text has been clarified and the Bibliography has been supplemented.

This document 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 — Pycnometer 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*

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This document 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 can 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 document.

The reference methods for normal weight aggregates 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 sieve and retained on the 4 mm sieve (Clause 8);
- a pyknometer method for aggregate particles passing the 4 mm sieve and retained on the 0,063 mm sieve (Clause 9).

In Clauses 7, 8 and 9, three different particle densities (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 is determined after soaking in water to constant mass.

For aggregate particles passing the 31,5 mm sieve and retained on the 4 mm sieve, the wire basket method in Clause 7 can be used as an alternative to the pyknometer method in Clause 8.

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 and retained on the 2 mm sieve.

The reference methods for lightweight aggregates are:

- a pyknometer method for aggregate particles passing the 31,5 mm sieve and retained on the 4 mm sieve (Annex C). Three different particle densities (oven-dried; saturated and surface-dried; apparent) and water absorption are determined after pre-drying and a soaking period of 24 h;
- a method, using a Büchner funnel, for aggregate particles passing the 4 mm sieve (Annex D). The three particle densities and water absorption are determined using a vacuum in the range of 50 mbar to 100 mbar for at least five minutes.

Three other methods for normal weight aggregates can be used to determine the pre-dried particle density, as specified in normative Annexes A and H:

- a wire basket method for aggregate particles passing the 63 mm sieve and retained on the 31,5 mm sieve (A.3);
- a pyknometer method for aggregate particles passing the 31,5 mm sieve and retained on the 0,063 mm sieve (A.4);
- a pyknometer method for aggregate particles passing the 31,5 mm sieve, including the 0/0,063 mm size fraction (Annex H).

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

The method in informative Annex F can be used to determine the particle density and water absorption of aggregate particles passing the 4 mm sieve.

Data on the density of water at various temperatures is specified in normative Annex G.

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

Precision data are presented in informative Annex J.

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.

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 1097-5, *Tests for mechanical and physical properties of aggregates — Part 5: Determination of the water content by drying in a ventilated oven*

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:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <https://www.electropedia.org/>

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.