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BSI Standards Publication

Lightweight aggregates

bsi.

National foreword

This British Standard is the UK implementation of EN 13055:2016. It supersedes BS EN 13055-1:2002 and BS EN 13055-2:2004 which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/502/5, Lightweight aggregates.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English Version

Lightweight aggregates

Granulats légers

Leichte Gesteinskörnungen

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European foreword

This document (EN 13055:2016) 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of an identical text or by endorsement, at the latest by November 2016, and conflicting national standards shall be withdrawn at the latest by February 2018.

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 13055-1:2002 and EN 13055-2:2004.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports basic work requirements of EU Regulation.

For relationship with EU Regulation see informative Annex ZA, which is an integral part of this document.

The most significant changes compared to the previous editions include:

a) Merging of the former 2 parts and simplifying the title of the standard;

b) Amending terminology and Annex ZA to be consistent with the Construction Products Regulation;

c) Clarifying the scope of the standard to cover construction products only;

d) Adding a new normative Annex A dealing with all source materials considered to be within the scope;

e) Referring certain recycled aggregates and MIBA to other aggregate standards (same product family);

f) Referring certain LWA for specific applications to other aggregate standards in a new normative Annex B;

g) Replacement of 3 former test method annexes with normative references to new, separate EN test method standards;

h) Reorganisation and alignment of text in subclauses under Clause 5 Product characteristics;

i) Adding a new general clause on dangerous substances;

j) Replacement of former clause on Evaluation of Conformity, and the normative text from the former annex on Factory Production Control, with new normative clauses on Assessment and Verification of Constancy of Performance;

k) Adding a new informative Annex D describing a test method for determination of water absorption for fine LWA.

No changes to existing technical classes and/or threshold levels have been made.

Characteristics for other aggregates are specified in the following European Standards:

— EN 12620, *Aggregates for concrete,*

— EN 13043, *Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas,*

— EN 13139, *Aggregates for mortar,*

— EN 13242, *Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction,*

— EN 13383-1, *Armourstone - Part 1: Specification,*

— EN 13450, *Aggregates for railway ballast.*

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, 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 properties of Lightweight Aggregates (LWA) and fillers derived thereof obtained by processing natural or manufactured materials and mixtures of these aggregates for concrete, mortar and grout, bituminous mixtures and surface treatments and for unbound and hydraulically bound applications in construction works.

This European Standard covers LWA of mineral origin having particle densities not exceeding 2000 kg/m^3 (2,000 Mg/m^3) or loose bulk densities not exceeding 1200 kg/m^3 (1,200 Mg/m^3) including:

a) natural LWA;

b) LWA manufactured from natural materials;

c) LWA manufactured from by-products of industrial processes or from recycled source materials;

d) LWA as by-products of industrial processes.

A list of source materials and specific materials, which are within the scope of this standard, is given in Annex A (normative).

NOTE Recycled aggregates from construction and demolition waste and Municipal Solid Waste Incinerator Bottom Ash (MIBA) are covered by EN 12620, EN 13043, EN 13139 and EN 13242.

Some LWA for specific applications are covered in separate European product Standards (Annex B, normative).

The requirements specified in this European Standard may not be equally relevant to all types of LWA. For particular applications, the requirements and tolerances can be adapted for the end use.

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 933-1, *Tests for geometrical properties of aggregates — Part 1: Determination of particle size distribution — Sieving method*

EN 933-10, *Tests for geometrical properties of aggregates — Part 10: Assessment of fines — Grading of filler aggregates (air jet sieving)*

EN 1097-1, *Tests for mechanical and physical properties of aggregates — Part 1: Determination of the resistance to wear (micro-Deval)*

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

EN 1097-3, *Tests for mechanical and physical properties of aggregates — Part 3: Determination of loose bulk density and voids*

EN 1097-4, *Tests for mechanical and physical properties of aggregates — Part 4: Determination of the voids of dry compacted filler*

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

EN 1097-6, *Tests for mechanical and physical properties of aggregates — Part 6: Determination of particle density and water absorption*

EN 1097-8, *Tests for mechanical and physical properties of aggregates — Part 8: Determination of the polished stone value*

EN 1097-9, *Tests for mechanical and physical properties of aggregates — Part 9: Determination of the resistance to wear by abrasion from studded tyres - Nordic test*

EN 1097-10, *Tests for mechanical and physical properties of aggregates — Part 10: Determination of water suction height*

EN 1097-11, *Tests for mechanical and physical properties of aggregates — Part 11: Determination of compressibility and confined compressive strength of lightweight aggregates*

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

EN 1367-7, *Tests for thermal and weathering properties of aggregates — Part 7: Determination of resistance to freezing and thawing of Lightweight aggregates*

EN 1367-8, *Tests for thermal and weathering properties of aggregates — Part 8: Determination of resistance to disintegration of Lightweight Aggregates*

EN 1744-1 *Tests for chemical properties of aggregates — Part 1: Chemical analysis*

EN 1744-3, *Tests for chemical properties of aggregates — Part 3: Preparation of eluates by leaching of aggregates*

EN 12664, *Thermal performance of building materials and products — Determination of thermal resistance by means of guarded hot plate and heat flow meter methods — Dry and moist products of medium and low thermal resistance*

EN 12667, *Thermal performance of building materials and products — Determination of thermal resistance by means of guarded hot plate and heat flow meter methods — Products of high and medium thermal resistance*

EN 12697-11, *Bituminous mixtures — Test methods for hot mix asphalt — Part 11: Determination of the affinity between aggregate and bitumen*

EN 13179-1, *Tests for filler aggregate used in bituminous mixtures — Part 1: Delta ring and ball test*

EN 13286-7, *Unbound and hydraulically bound mixtures — Part 7: Cyclic load triaxial test for unbound mixtures*

EN ISO 10456, *Building materials and products — Hygrothermal properties —Tabulated design values and procedures for determining declared and design thermal values (ISO 10456)*

3 Terms and definitions

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

3.1
lightweight aggregate
granular material of mineral origin having a particle density not exceeding 2000 kg/m^3 (2,00 Mg/m^3) or a loose bulk density not exceeding 1200 kg/m^3 (1,20 Mg/m^3). Lightweight aggregate can be natural, manufactured from natural sources, manufactured from by-products or recycled source materials and by-product aggregates

3.2
natural lightweight aggregate
aggregate from mineral sources which has been subjected to nothing more than mechanical processing

3.3
manufactured lightweight aggregate
aggregate of mineral origin resulting from an industrial process involving thermal or other modification

3.4
by-product lightweight aggregate
aggregate of mineral origin from an industrial process which subsequently has been subjected to nothing more than mechanical processing

3.5
recycled source material
raw material of inorganic or mineral origin from waste sources for use in manufactured LWA

3.6
recycled aggregate
aggregate resulting from processing of inorganic or mineral material previously used in construction

3.7
fine lightweight aggregate (fines)
designation given to the smaller aggregate size with d equal to or greater than 0 mm and D less than or equal to 4 mm

3.8
coarse lightweight aggregate
designation given to the larger aggregate size with d equal to or greater than 2 mm and D greater than 4 mm

3.9
all in lightweight aggregate
designation given to the aggregate size with d equal to or greater than 0 mm and D greater than 4 mm

3.10
lightweight aggregate filler
fine lightweight aggregate, most of which passes a 0,063 mm sieve

3.11
grading
particle size distribution expressed as the percentage by mass passing a specified number of sieves

3.12
aggregate size
designation of aggregate in terms of lower sieve (d) and upper sieve (D) sizes expressed as d/D

Note 1 to entry: The designation accepts the presence of some particles which are retained on the upper sieve (oversize) and some particles which pass the lower sieve (undersize).

3.13
constant mass
successive weightings after drying and conditioning at least 1 h apart not differing by more than 0,1 %

3.14
declared value
value that a manufacturer is confident in achieving, taking into account the precision of test methods used, the variability of the production process(es) and the product performance

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

CWFT Classification Without Further Testing

d lower sieve size

D upper sieve size

DoP Declaration of Performance

FPC Factory production control

LWA lightweight aggregate(s)

PSV polished stone value

5 Product characteristics

5.1 General

The necessity for testing and declaring all characteristics specified in this clause shall be limited according to the particular application at end use or origin of the aggregate. When required, the tests specified shall be carried out to determine appropriate characteristics.

5.2 Density

5.2.1 Loose bulk density

The loose bulk density shall be determined in accordance with EN 1097-3 and a value declared. Measured values shall be in the range of ± 15 % with a maximum of ± 100 kg/m^3 (0,100 Mg/m^3) of the declared value.

NOTE It is advised to fill the container using a standard scoop held centrally over the container and without touching it.

5.2.2 Particle density

When required, the particle density shall be determined in accordance with EN 1097-6 and a value declared. Measured values shall be in the range of ± 15 % with a maximum of ± 150 kg/m^3 (0,150 Mg/m^3) of the declared value.

NOTE This test method may not be applicable to all LWA having a bulk density of less than 150 kg/m^3 (0,150 Mg/m^3).

5.3 Aggregate size

5.3.1 General

Aggregate sizes shall be determined using a pair of sieve sizes selected from the basic set, or the basic set plus set 1, or the basic set plus set 2 specified in Table 1 and the upper and lower sizes declared as product designation.

NOTE The declaration accepts the presence of some particles, which will be retained on the upper sieve (referred to as (D)) and some, which will pass the lower sieve (referred to as (d)).

Table 1 — Sieve sizes for specifying aggregate sizes

Basic set (mm)	**Basic set plus set 1 (mm)**	**Basic set plus set 2 (mm)**
0	0	0
0,25	0,25	0,25
0,5	0,5	0,5
1	1	1
2	2	2
-	2,8 (3)	3,15 (3)
4	4	4
-	5,6 (5)	-
-	-	6,3 (6)
8	8	8
-	-	10
-	11,2 (11)	-
-	-	12,5 (12)
-	-	14
16	16	16
-	-	20
-	22,4 (22)	-
31,5 (32)	31,5 (32)	31,5 (32)
-	-	40
-	45	-
63	63	63
NOTE Figures in parenthesis can be used to provide simplified descriptions of aggregate sizes.		

5.3.2 Undersize

The quantity of the undersize passing the lower sieve (d) shall not exceed 15 % by mass.

5.3.3 Oversize

The quantity of the oversize retained on the upper sieve (D) shall not exceed 10 % by mass. When required, the sieve through which 100 % of the aggregate passes shall be declared.

5.4 Grading

When required, the particle size distribution shall be determined in accordance with EN 933-1 without washing and a grading declared.

NOTE It is advised to take care with friable aggregates to prevent degradation.

5.5 Content of fines in LWA

When required, the content of fines in LWA shall be determined in accordance with EN 933-1 without washing and a value declared.

NOTE It is advised to take care with friable aggregates to prevent degradation.

5.6 Grading of LWA filler

When required, the particle size distribution of LWA filler shall be determined in accordance with EN 933-10 and a grading declared.

5.7 Particle shape

When required, particle shape shall be described.

NOTE The test methods for normal weight aggregates are not applicable to LWA.

5.8 Water content

When required, the water content of LWA shall be determined in accordance with EN 1097-5 and a value declared.

5.9 Water absorption

When required, the water absorption of coarse LWA shall be determined in accordance with EN 1097-6 and a value declared.

NOTE EN 1097-6 is not an appropriate test method for fine LWA. Water absorption of fine LWA can be determined in accordance with Annex D.

5.10 Bulk crushing resistance

When required, the bulk crushing resistance of LWA shall be determined in accordance with Annex C and a value declared.

NOTE 1 There is no simple relationship between the bulk crushing resistance of LWA and the properties at its end use.

NOTE 2 The bulk crushing resistance is intended only for factory production control and quality documentation.

5.11 Crushed particles

When required, the presence of crushed particles shall be described.

NOTE The test methods for normal weight aggregates are not applicable to LWA.

5.12 Resistance to disintegration

When required, the resistance to disintegration of LWA shall be determined in accordance with EN 1367-8 and a value declared.

NOTE This test method may not be applicable to all LWA having a bulk density of less than 150 kg/m^3 (0,150 Mg/m^3).

5.13 Freezing and thawing resistance

When required, and in accordance with the provisions valid in the place of use, the resistance to freezing and thawing of LWA used in exposed hydraulically and unbound applications (U4 in Table A.1) having a particle size of not less than 4 mm and a bulk density of not less than 150 kg/m^3 (0,150 Mg/m^3) shall be determined in accordance with EN 1367-7 and a value declared.

When the resistance to freezing and thawing of LWA of 4 mm or less or a bulk density of less than 150 kg/m^3 (0,150 Mg/m^3) is required in the end use situation, it shall be derived from freeze-thaw tests on the final product in accordance with the provisions valid in the place of use.

Alternatively, aggregates can be assessed on the basis of satisfactory service record of performance or tests on the final product.

5.14 Water suction height

When required, the water suction height of LWA shall be determined in accordance with EN 1097-10 and a value declared.

5.15 Compressibility and confined compressive strength

When required, the compressibility and confined compressive strength of LWA shall be determined in accordance with EN 1097-11 and values declared.

NOTE This test method developed for LWA having a bulk density of not less than 150 kg/m^3 (0,150 Mg/m^3) has not been fully evaluated with all types of LWA.

5.16 Resistance to cyclic compressive loading

When required, the resistance to cyclic compressive loading of LWA shall be determined in accordance with EN 13286-7 and a value declared.

NOTE This test method may not be applicable to all LWA.

5.17 Stiffening properties

When required, the stiffening properties of LWA filler in bituminous mixtures shall be determined in accordance with EN 13179-1 and a value declared.

5.18 Voids of dry compacted LWA filler

When required the voids of dry compacted LWA filler shall be determined in accordance with EN 1097-4 and a value declared.

NOTE This test method may not be applicable to all LWA.

5.19 Resistance to thermal shock

When required the resistance to thermal shock of LWA shall be determined in accordance with EN 1367-5 and a value declared.

NOTE This test method may not be applicable to all LWA.

5.20 Resistance to polishing

When required the polished stone value (PSV) of coarse LWA shall be determined in accordance with EN 1097-8 and a value declared.

NOTE This test method may not be applicable to all LWA.

5.21 Resistance to wear by abrasion from studded tyres of coarse LWA in surface treatments

When required the resistance to abrasion from studded tyres shall be determined in accordance with EN 1097-9 and a value declared.

NOTE This test method may not be applicable to all LWA.

5.22 Affinity between LWA and bitumen

When required the affinity between LWA and bitumen shall be determined in accordance with EN 12697-11 and a value declared.

NOTE This test method may not be applicable to all LWA.

5.23 Resistance to fragmentation

When required the resistance to fragmentation (Los Angeles) of coarse LWA shall be determined in accordance with EN 1097-2 and a value declared.

NOTE This test method may not be applicable to all LWA.

5.24 Resistance to wear

When required the resistance to wear (micro-Deval) of coarse LWA shall be determined in accordance with EN 1097-1 and a value declared.

NOTE This test method may not be applicable to all LWA.

5.25 Chemical characteristics

5.25.1 General

The necessity for testing and declaring all characteristics in this clause is limited to particular application at end use or origin of the aggregate. When required the tests specified in this clause shall be carried out to determine the appropriate chemical content by mass. If comparing a determination to a limiting value the chemical content by mass shall be converted to a comparison value in accordance with the following formula:

$$V_c = V_m \cdot \frac{loose\ bulk\ density}{1500}$$

where

V_c is the comparison value;

V_m is the value measured in accordance with EN 1744-1;

1500 is the assumed nominal loose bulk density of normal weight aggregate in kg/m^3.

NOTE Further guidance is given in Annex E.

5.25.2 Water solubility

When required the water solubility of LWA filler used in bituminous mixtures shall be determined in accordance with EN 1744-1 and a value declared.

5.25.3 Chloride

When required the water-soluble chloride ion content shall be determined in accordance with EN 1744-1 and a value declared.

NOTE Further guidance is given in Annex F.

5.25.4 Sulphur containing compounds

5.25.4.1 Acid-soluble sulphate

When required the acid-soluble sulphate content shall be determined in accordance with EN 1744-1, and a value declared.

NOTE Further information is given in Annex F.

5.25.4.2 Total sulphur

When required the total sulphur content shall be determined in accordance with EN 1744-1 and a value declared.

NOTE Further information is given in Annex F.

5.25.5 Loss on ignition

When required the loss on ignition of LD source materials (see Table A.2) shall be determined in accordance with EN 1744-1 and a value declared.

5.25.6 Water-soluble constituents

When required the water-soluble constituents shall be determined in accordance with EN 1744-3 and a value declared.

5.25.7 Organic contaminators

When required harmful components in natural LWA i.e., those which alter the rate of setting and hardening of concrete, mortar and grout shall be determined in accordance with EN 1744-1 and a 'pass' result declared.

NOTE Further guidance is given in Annex F.

5.25.8 Alkali-silica reactivity of natural LWA

When required, the alkali-silica reactivity of natural LWA shall be assessed in accordance with the provisions valid in the place of use.

NOTE Guidance on the effects of alkali-silica reactivity is given in Annex F.

5.26 Dangerous substances

National regulations on dangerous substances may require verification and declaration on release, and sometimes content, when construction products covered by this standard are placed on those markets. In the absence of European harmonized test methods, verification and declaration on release/content should be done taking into account national provisions in the place of use.

NOTE An informative database covering European and national provisions on dangerous substances is available at the Growth website on EUROPA accessed through:

http://ec.europa.eu/growth/tools-databases/cp-ds/index_en.htm

5.27 Thermal conductivity

5.27.1 General

When required the thermal conductivity of LWA (including air voids) shall be determined in the air dry condition in accordance with either EN 12664 or EN 12667 in the case of dry LWA with a thermal conductivity value less than 0,15 W/(mK).

NOTE Thermal conductivity cannot be included in CE-marking according to this European Standard. Annex B provides a list of harmonized standards covering LWA and their applications, where CE-marking of thermal conductivity can be made.

5.27.2 Correction for moisture

Design values shall be obtained by correcting measured values in accordance with EN ISO 10456 and declared.

6 Testing

6.1 Sampling and sample reduction

Sampling shall be carried out in accordance with EN 932-1, and if required, sample reduction shall be carried out in accordance with EN 932-2.

NOTE To ensure a representative sample, it is advised to take care to minimize segregation and degradation.

6.2 Quantity of test specimens

The test specimen quantity specified in any test method shall, if not taken into account for LWA, be corrected on the basis of loose bulk density (see example in Annex E).

6.3 Preparation of test specimens for thermal conductivity testing

6.3.1 Drying

Test specimens shall be dried in accordance with EN 1097-5.

6.3.2 Conditioning after drying

Allow the test specimen to cool to room temperature. When required allow the test specimen to condition to moisture equilibrium at (23 ± 5)°C and (50 ± 10) % relative humidity.

6.3.3 Preparation of test specimens

Care shall be taken to avoid excessive segregation and crushing when placing material in the apparatus. The density of the specimen shall be determined and declared, based on the mass of the specimen and the dimensions of the specimen enclosure.

6.3.4 Thickness of test specimens

Test specimens shall be at least 10 times as thick as the mean aggregate size in the sample.

NOTE Test specimens with a thickness of five times the mean aggregate size are permitted if it can be shown that the required testing accuracy is obtained.

7 Assessment and verification of constancy of performance - AVCP

7.1 General

The compliance of LWA with the requirements of this standard and with the performance declared by the manufacturer in the DoP (Declaration of Performance) shall be demonstrated by:

— determination of the product type on the basis of type testing

— factory production control by the manufacturer, including product assessment.

The manufacturer shall retain overall control and shall have the necessary means to take responsibility for the conformity of the product with its declared performance.

7.2 Type testing

7.2.1 General

Product performance shall be determined by testing when the manufacturer intends to declare the respective characteristics, unless this standard gives provisions for declaring them without performing tests (such as the use of existing data, CWFT and conventionally accepted performance e.g. from databases).

Assessments previously performed in accordance with the provisions of this standard, may be taken into account provided that they were carried out on the same or a more rigorous basis under the same AVCP system and on the same or similar products and production processes.

For the purposes of assessment products may be grouped into families, where the results for one or more characteristics from any product are representative for the same characteristics for all products within the same family.

Reference to sampling method standards should be made to allow the selection of a representative sample.

Type testing shall be performed for all characteristics for which the manufacturer declares the performance:

— at the beginning of the production of new or modified LWA (where this may affect the declared characteristics), or

— at the beginning of a new or modified method of production (where this may affect the declared characteristics);

Type testing shall be repeated for the appropriate characteristic(s), whenever a change occurs in the LWA, in the raw materials or components for LWA mixtures, or the method of production (subject to the grouping of a family), which would significantly affect one or more of the declared characteristics.

Raw materials and components (for LWA mixtures), bearing regulatory marking in accordance with this standard, may be presumed to have the performance declared in their respective DoP, although this does not replace the responsibility on the LWA manufacturer to ensure that the mixture and LWA product as a whole is correctly manufactured and the final LWA product has the declared performance values.

7.2.2 Test samples and testing

Sampling shall be carried out in accordance with 6.1 and 6.2.

The number of samples of LWA to be tested is given in the appropriate test standard or annex, and the number of necessary test results shall be assessed by the manufacturer.

7.2.3 Shared results

A manufacturer may use the results of the product type determination obtained by someone else (e.g. by another manufacturer, as a common service to manufacturers, or by a product developer) to justify his own DoP regarding a product that is manufactured with similar raw materials, constituents and manufacturing methods, provided that

— the owner of the results has granted permission;

NOTE Such permission can be by licence, contract, or any other type of written consent.

— the results are known to be valid for products with the essential characteristics relevant for the product performance;

— in addition to any information essential for confirming that the product has such same performance related to specific essential characteristics, the other party who has carried out the type testing concerned or has had it carried out, has expressly accepted by agreement to transmit to the manufacturer the results and the test report to be used for the manufacturer's type testing documentation, as well as information regarding production facilities and the production control process that can be taken into account for FPC;

— the manufacturer using shared results accepts responsibility for the product having the declared performance.

7.2.4 Test reports

The results of type testing and shared results shall be documented in test reports. Test reports shall be retained by the manufacturer for at least 10 years after the LWA products have been placed on the market.

7.3 Factory production control (FPC)

7.3.1 General

The manufacturer shall establish, document and maintain an FPC system to ensure that the products placed on the market comply with the declared performance of the essential characteristics.

The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components for LWA mixtures, equipment, the production process and the product, as appropriate.

All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures.

When the manufacturer has used shared type testing results, the FPC shall also include the appropriate documentation as described in 7.2.3.

A procedure concerning the management of documents and data shall be included in the FPC manual.

7.3.2 Requirements

7.3.2.1 General

The manufacturer is responsible for organizing the effective implementation of the FPC system in line with this standard. Production control tasks and responsibilities in the production control organization shall be documented and kept up to date.

The responsibility, authority and the relationship between personnel, managing, performing or verifying work affecting product constancy, shall be defined. This applies in particular to personnel,

who need to initiate actions preventing the occurrence of non-constancies in product performance, actions in case of non-constancies and to identify and record constancy problems.

Personnel performing work affecting the constancy of performance of the product shall be competent in terms of appropriate training, skills and experience for which records shall be maintained. In each factory, the manufacturer may delegate the action to a person having the necessary authority to:

— identify procedures to demonstrate constancy of performance of the product at appropriate stages;

— identify and record any instance of non-constancy;

— identify procedures to correct instances of non-constancy.

The manufacturer shall draw up and keep up-to-date documents defining the factory production control. The manufacturer's documentation and procedures should be appropriate to the product and manufacturing process. The FPC system should achieve an appropriate level of confidence in the constancy of performance of the product. This involves:

a) the preparation of documented procedures and instructions relating to factory production control operations, in accordance with the requirements of the technical specification to which reference is made;

b) the effective implementation of these procedures and instructions;

c) the recording of these operations and their results;

d) the use of these results to correct any deviations, repair the effects of such deviations, treat any resulting instances of non-conformity and, if necessary, revise the FPC to rectify the cause of non-constancy of performance.

Where subcontracting takes place, the manufacturer shall retain the overall control of the product and ensure that he receives all the information necessary to fulfil his responsibilities according to this standard and may under no circumstances pass the above responsibilities on to a subcontractor.

Any FPC system complying with EN ISO 9001, and made specific to the requirements of this European Standard, is deemed to satisfy the requirement of FPC.

7.3.2.2 Equipment

7.3.2.2.1 Testing

All weighing, measuring and testing equipment shall be calibrated and regularly inspected according to documented procedures.

7.3.2.2.2 Manufacturing

All equipment used in the manufacturing process shall be regularly inspected and maintained to ensure use, wear or failure does not cause inconsistency in the manufacturing process. Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer’s documented procedures and the records retained for the period defined in the manufacturer's FPC procedures.

7.3.2.3 Raw materials and components for LWA mixtures

The specifications of all incoming raw materials and components for LWA mixtures shall be documented as well as the inspection scheme for ensuring their compliance.

7.3.2.4 Traceability and marking

Products, product batches or packaging shall be identifiable and traceable with regard to their production origin and procedures for this documented.

7.3.2.5 Controls during manufacturing process

The manufacturer shall plan and carry out production under controlled conditions.

7.3.2.6 Product testing and evaluation

The manufacturer shall establish procedures to ensure that the declared characteristics are maintained. The characteristics, the means of control and indicative frequencies for finished product testing are given in Table G.1 (informative Annex G).

7.3.2.7 Non-complying products and corrective actions

The manufacturer shall have written procedures, which specify how non-complying products shall be dealt with. Any such events shall be recorded as they occur and these records shall be kept for the period defined in the manufacturer's written procedures.

Where the product fails to satisfy the acceptance criteria, the provisions for non-complying products shall apply, the necessary corrective action(s) shall immediately be taken and the products or batches not complying shall be isolated and properly identified.

Once the fault has been corrected, the test or verification in question shall be repeated.

The results of controls and tests shall be properly recorded. The product description, date of manufacture, test method adopted, test results and acceptance criteria shall be entered in the records under the signature of the person responsible for the control/test.

With regard to any control result not meeting the requirements of this standard, the corrective actions taken to rectify the situation (e.g. further testing, modification of manufacturing process, change of one or more declared characteristics or intended use(s), re-processing or discarding) shall be indicated in the records.

7.3.2.8 Handling, storage and packaging

The manufacturer shall have procedures providing methods of product handling and shall provide suitable storage areas preventing deterioration.

7.3.3 The FPC system and compliance with the DoP

The FPC system shall address this European Standard and ensure that the products placed on the market comply with the DoP.

The FPC system shall identify procedures to demonstrate compliance of the product at appropriate stages, i.e.:

a) controls and tests to be carried out prior to and/or during production according to a frequency laid down in the FPC test plan, and/or

b) verifications and tests to be carried out on finished products according to a frequency laid down in the FPC test plan.

If the manufacturer only performs tests on finished products, the operations under b) shall lead to an equivalent level of compliance of the product as if process control had been carried out.

The operations under a) refer to the intermediate states of the production process and the adjustment of associated equipment. Controls and test frequencies shall be chosen based on product type and

composition, the production process and its complexity, the sensitivity of product features to variations in production parameters etc.

The manufacturer shall establish and maintain records providing evidence that show clearly whether the products have satisfied the defined acceptance criteria. The records shall be available upon request from market surveillance authorities for at least 10 years after the LWA products have been placed on the market.

7.3.4 Initial inspection of factory and FPC covered under AVCP system 2+

Initial inspection of factory and FPC shall be carried out when the production process has been finalized and in operation. The factory and FPC documentation shall be assessed to verify that the requirements in 7.3.2 and 7.3.3 are fulfilled.

During the inspection it shall be verified that

a) all resources necessary for the achievement of the product characteristics included in this European Standard are in place and correctly implemented, and

b) the FPC-procedures in accordance with the FPC documentation are followed in practice, and

c) the product complies with the product type samples, for which compliance of the product performance to the DoP has been verified.

All locations where final testing of the relevant product is performed shall be assessed to verify that conditions a) to c) are in place and implemented. If the FPC system covers more than one product, production line or production process, and it is verified that the general requirements are fulfilled when assessing one product, production line or production process, then the assessment of the general requirements does not need to be repeated when assessing the FPC for another product, production line or production process.

All assessments and their results shall be documented in the initial inspection report.

7.3.5 Continuous surveillance of FPC covered under AVCP system 2+

Surveillance of the FPC shall be undertaken once per year. The surveillance of the FPC shall include a review of the FPC test plan(s) and production processes(s) for each product to determine if any changes have been made since the last assessment or surveillance. The significance of any changes shall be assessed.

Checks shall be made to ensure that the test plans are still correctly implemented and that the production equipment is still correctly maintained and calibrated at appropriate time intervals.

The records of tests and measurement made during the production process and to finished products shall be reviewed to ensure that the values obtained still correspond with those values for the samples used for determination of the product type.

Checks shall be made to ensure that the correct actions have been taken for non-complying products.

7.3.6 Procedure for modifications

If modifications are made to the product, production process or FPC system that could change any of the declared characteristics, then all the characteristics for which the manufacturer declares performance, which are affected by the modification, shall be subject to type testing, as described in 7.2.1.

Where relevant, a re-assessment of the factory and of the FPC system shall be performed for those aspects, which are affected by the modification. All assessments and their results shall be documented in a report.

7.3.7 Prototypes and custom-made products

For type assessment, the provisions of 7.2.1, 3rd paragraph apply, together with the following additional provisions:

— in case of prototypes, the test samples shall be representative of the intended future production and shall be selected by the manufacturer;

— at the request of the manufacturer, the results of the assessment of prototype samples may be included in a certificate or in test reports issued by the involved third party, if any.

The provisions for raw materials and/or components shall apply only where appropriate. The manufacturer shall maintain records allowing traceability of the product.

For prototypes, where the intention is to move to series production, the initial inspection of the factory and FPC shall be carried out before the production is already running and/or before the FPC is already in place. The following shall be assessed:

— the FPC-documentation; and

— the factory.

In the initial assessment of the factory and the FPC system it shall be verified:

a) that all resources necessary for the achievement of the product characteristics included in this European Standard will be available, and

b) that the FPC-procedures in accordance with the FPC-documentation will be implemented and followed in practice, and

c) that procedures are in place to demonstrate that the factory production processes can produce a product complying with the requirements of this European Standard and that the product will be the same as the samples used for the determination of the product type, for which compliance with this European Standard has been verified.

Once series production is fully established, the general provisions of 7.3 shall apply.

8 Designation, supply, marking and labelling

8.1 Designation

LWA shall be identified in the following terms:

a) name of manufacturer or trademark;

b) LWA type(s) (see Table A.2);

c) Intended use(s) (see Table A.1)

d) aggregate size;

e) loose bulk density;

f) reference to this European Standard;

g) any additional information needed to identify the particular LWA.

The designation may be partially abbreviated as follows:

LWA type(s)	Intended use(s)	Aggregate size	Loose bulk density
LA1 to LD3	U1 to U4	AS	LBD

Example 1 (single-type aggregate):

Expanded clay – Intended for concrete, unbound and hydraulically bound mixtures –

Aggregate size: 8/16 mm – Loose bulk density 250 kg/m^3:

LB1 - U1+U4 - AS(8/16) - LBD250

Example 2 (mixture of aggregates):

Expanded clay + expanded glass – Intended for concrete, mortar and grout – Aggregate size: 0-4 mm – Loose bulk density 420 kg/m^3:

LB1 + LC5 - U1+U2 - AS(0/4) – LBD420

8.2 Supply

LWA shall be supplied by volume or mass and be protected against contamination.

Every consignment of LWA shall be identified by a numbered delivery note containing the following information:

a) Designation (see 8.1)

b) source or place of manufacture;

c) date of dispatch from the suppliers works;

d) quantity;

e) customer's name and address.

8.3 Marking and labelling

For CE marking and labelling see ZA.1.

Annex A
(normative)

Source materials considered in the development of EN 13055 and their status in respect of the scope of the standard

The source materials listed in this annex have been considered in the preparation of this standard. Their status within the standard is indicated in Table A.2. Source materials not described here are outside the scope of EN 13055.

NOTE It is the intention to keep this inventory under continual review. Any relevant information to assist in the updating of this annex including any proposal for the incorporation of new source material types can be considered.

Source materials with no history of use, according to one or more of the intended uses specified in Table A.1, are outside the scope of the standard.

Source materials with a positive history of use and no identification of the need for additional requirements are fully within the scope of the standard.

Source materials with a positive history of use and where the need for additional requirements has been identified are provisionally within the scope pending the inclusion of suitable requirements and test methods.

In situations where the need for additional requirements has been identified, such materials, when placed on the market as aggregates, should comply with this standard but may also be required to comply with specific relevant additional requirements at the place of use. Additional characteristics and requirements may be specified on a case-by-case basis depending upon experience of use of the product, and defined in specific contractual documents.

In all cases there is an obligation to assess the potential release of regulated dangerous substances (RDS) in accordance with Member State requirements at the place of use (see 5.26).

Table A.1 — Intended uses for lightweight aggregates (LWA)

Intended uses	**Concrete**	**Mortar and grout**	**Bituminous mixtures and surface treatments**	**Unbound and hydraulically bound mixtures (other than concrete, mortar and grout)**
Codes in Table A.2	U1	U2	U3	U4

Table A.2 — Inventory list of source materials for lightweight aggregates (LWA)

No.	Source material	Sub No.	Specific LWA material	Positive history of intended uses [a]	Specific requirements in this standard	Additional requirements identified for inclusion
LA	Natural LWA	LA1	Pumice	U1,U2, U4	Yes	No
		LA2	Scoria	U1	Yes	No
		LA3	Tuff	U1, U4	Yes	No
LB	Manufactured LWA from natural source materials	LB1	Expanded clay	U1, U2, U3, U4	No	No
		LB2	Expanded shale	U1, U2, U3, U4	No	No
		LB3	Expanded slate	U1, U2, U3, U4	No	No
		LB4	Expanded perlite	U1, U2, U3, U4	No	No
		LB5	Exfoliated vermiculite	U1, U2, U3, U4	No	No
LC	Manufactured LWA from by-products of industrial processes or recycled source materials	LC1	Sintered fly ash	U1, U2, U3, U4	No	No
		LC2	Cold bonded fly ash	U1, U2, U4	No	No
		LC3	Foamed blast furnace slag [b]	U1, U2, U4	No	No
		LC4	Expanded pelletized blast furnace slag [b]	U1, U2, U4	No	No
		LC5	Expanded glass	U1, U2, U3, U4	No	Yes
		LC6	Foamed glass	U1, U4	No	Yes
LD	LWA as by-products of industrial processes	LD1	Furnace clinker [c, d]	U1, U2, U4	Yes	No
		LD2	(Furnace) Bottom ash (BA, FBA) [d]	U1, U2, U3, U4	Yes	No
		LD3	Fly ash (FA, PFA) [d]	U1, U2, U3, U4	Yes	No

[a] Intended uses/applications as defined in Table A.1.

[b] From iron- and steel production

[c] Ash from boilers fired with coal, which has not been pulverized, typically known as chain-grate or spreader-stoker boilers.

[d] From coal fired power generation

Appendix to the NOTE: Procedure for the incorporation of new source materials

General procedure:

A request for the inclusion of new source materials into the standards for aggregates will be taken into account with a positive history of use when this request is made by at least one of the CEN members (NSBs) and the request is based on the actual routine application of an aggregate from this new source on the market.

The request will formally be taken into consideration.

The basic information on the following items to be provided as an input for the request:

— Definition (clear description of the source);

— Field(s) of application (which intended use(s) according to Table A.1 is(are) applicable);

— Technical information (material properties and end use information);

— Experience/quantity/demonstration;

— Criteria used to control the quality of material according to the standards (relevant properties and required test results);

— Additional requirements necessary to consider within the standard (including any information on the release of regulated dangerous substances).

Annex B
(normative)

Standards covering other applications of LWA

This standard does not apply to expanded clay, expanded perlite or exfoliated vermiculite for loose-fill thermal insulation applications or to expanded clay for civil engineering applications. Requirements for these LWA in these applications are covered by the following standards:

EN 14063-1, Thermal insulation material products – In-situ formed expanded clay lightweight aggregate products (LWA) — Part 1: Specification for the loose-fill products before installation

EN 14063-2, Thermal insulation products for buildings – In-situ formed expanded clay lightweight aggregate products — Part 2: Specification for the installed products

EN 14316-1, Thermal insulation products for buildings – In-situ thermal insulation formed from expanded perlite (EP) products — Part 1: Specification for bonded and loose-fill products before installation

EN 14316-2, Thermal insulation products for buildings – In-situ thermal insulation formed from expanded perlite (EP) products — Part 2: Specification for the installed products

EN 14317-1, Thermal insulation products for buildings – In-situ thermal insulation formed from exfoliated vermiculite (EV) products — Part 1: Specification for bonded and loose-fill products before installation

EN 14317-2, Thermal insulation products for buildings – In-situ thermal insulation formed from exfoliated vermiculite (EV) products — Part 2: Specification for the installed products

EN 15599-1, Thermal insulation products for building equipment & industrial installations – In-situ thermal insulation formed from expanded perlite (EP) products — Part 1: Specification for the bonded and loose-fill products before installation

EN 15599-2, Thermal insulation products for building equipment & industrial installations – In-situ thermal insulation formed from expanded perlite (EP) products — Part 2: Specification for the installed products

EN 15600-1, Thermal insulation products for building equipment & industrial installations – In-situ thermal insulation formed from exfoliated vermiculite (EV) products — Part 1: Specification for the bonded and loose-fill products before installation

EN 15600-2, Thermal insulation products for building equipment & industrial applications – In-situ thermal insulation formed from exfoliated vermiculite (EV) products — Part 2: Specification for the installed products

EN 15732, Lightweight fill and thermal insulation products for civil engineering applications (CEA) – Expanded clay lightweight aggregate products (LWA)

Annex C
(normative)

Determination of bulk crushing resistance

C.1 Principle

A prepared sample of lightweight aggregate is placed in a specified steel cylinder and compacted by vibration. A piston is then forced under pressure into the cylinder for a given distance, and the force required is measured and expressed as the resistance to crushing.

Two test procedures are specified. Procedure 1 is normally applicable to lightweight aggregate in the size range 4 mm to 22 mm and with a bulk density above 150 kg/m^3 (0,150 Mg/m^3). Procedure 2 is normally applicable to a lightweight aggregate with a bulk density of 150 kg/m^3 (0,150 Mg/m^3) and below.

C.2 Apparatus

C.2.1 All apparatus, unless stated below, shall conform to the general requirements of EN 932-5.

C.2.2 Steel test cylinder and piston, as shown in Figure C.1 for procedure 1 and Figure C.2 for procedure 2.

NOTE It is important that the test cylinder is tightened to the vibration table during the vibration to ensure the same amplitude of the cylinder and aggregates as for the table.

C.2.3 Hydraulic press, or similar device capable of providing sufficient pressure for the test and measuring the pressure to an accuracy of ± 5 %.

C.2.4 Vibrating table, operating at approximately 3000 oscillations per minute (50 Hz ± 1 Hz) and amplitude (0,5 ± 0,05) mm with the equipment used during vibration in place.

NOTE It is important that the vibrating table is levelled horizontally, otherwise the vibration amplitude maybe uneven for the aggregates inside the cylinder in addition to unnecessary wear of the test equipment.

C.2.5 Steel straightedge, of a suitable length.

C.2.6 Scoop, of suitable size to fill the test cylinder.

C.2.7 Thermostatically controlled ventilated drying oven, capable of a temperature of (110 ± 5)°C.

C.3 Preparation of test specimens

Samples shall be taken in accordance with EN 932-1. The samples shall be dried to constant weight in accordance with EN 1097-5. The samples are divided in accordance with EN 932-2 into three test specimens of a volume of 1,2 – 1,5 litres each after removal of undersize and oversize.

C.4 Procedure

C.4.1 Procedure 1

Place the cylinder with lower and upper part on the vibrating table, and gently fill the whole test specimen into the cylinder. Vibrate for 6 s to 120 s. Remove the top rail (upper part of the cylinder) and level the surface of the lightweight aggregates using the straight edge. Alternatively only the lower part of the cylinder can be used. Vibrate then twice 3 s to 60 s and refill between the two vibrations.

NOTE If both cylinder parts are used, it is important that they are securely fixed together to ensure equal amplitude of vibration of the two parts.

Position the top rail on the cylinder and place the piston on the surface of the compacted LWA. Adjust the distance between the contact ring and the top rail to 20 mm and place the test assembly in the hydraulic press.

Increase the force on the piston to reach a compression of 20 mm in approximately 100 s, and record the force in newtons. Repeat the procedure with the remaining two test specimens.

C.4.2 Procedure 2

Place the cylinder on the vibrating table and gently fill to overflowing by discharging the test specimen using a scoop, taking care to minimize the segregation of the LWA. Vibrate the cylinder for 3 s and fit the flanged collar on the test cylinder. Add additional LWA to fill the collar and vibrate for a further 3 s.

Remove the collar and level the lightweight aggregate and place the test assembly in the hydraulic press.

Increase the force on the piston to reach a compression of 50 mm in approximately 100 s, and record the force in newtons.

Repeat the procedure with the remaining two test specimens.

C.5 Calculation and expression of results

Calculate the crushing resistance (C_a or C_b) for each test specimen using the following formula:

$$C_a \text{ or } C_b = \frac{L + F}{A} \qquad \text{N/mm}^2$$

where

C_a is the crushing resistance, in newtons per square millimetre (N/mm²), determined in accordance with procedure 1;

C_b is the crushing resistance, in newtons per square millimetre (N/mm²), determined in accordance with procedure 2;

L is the force exerted by the piston in newtons (N);

F is the compression force in newtons (N);

A is the area of the piston in square millimetres (mm²).

Calculate the mean value of the three results, and give the results with at least two significant figures.

C.6 Test report

The test report shall include the following information:

a) reference to this European Standard, Annex C;

b) test carried out in accordance with procedure 1 or procedure 2;

c) identification of the test specimen;

d) identification of the test laboratory;

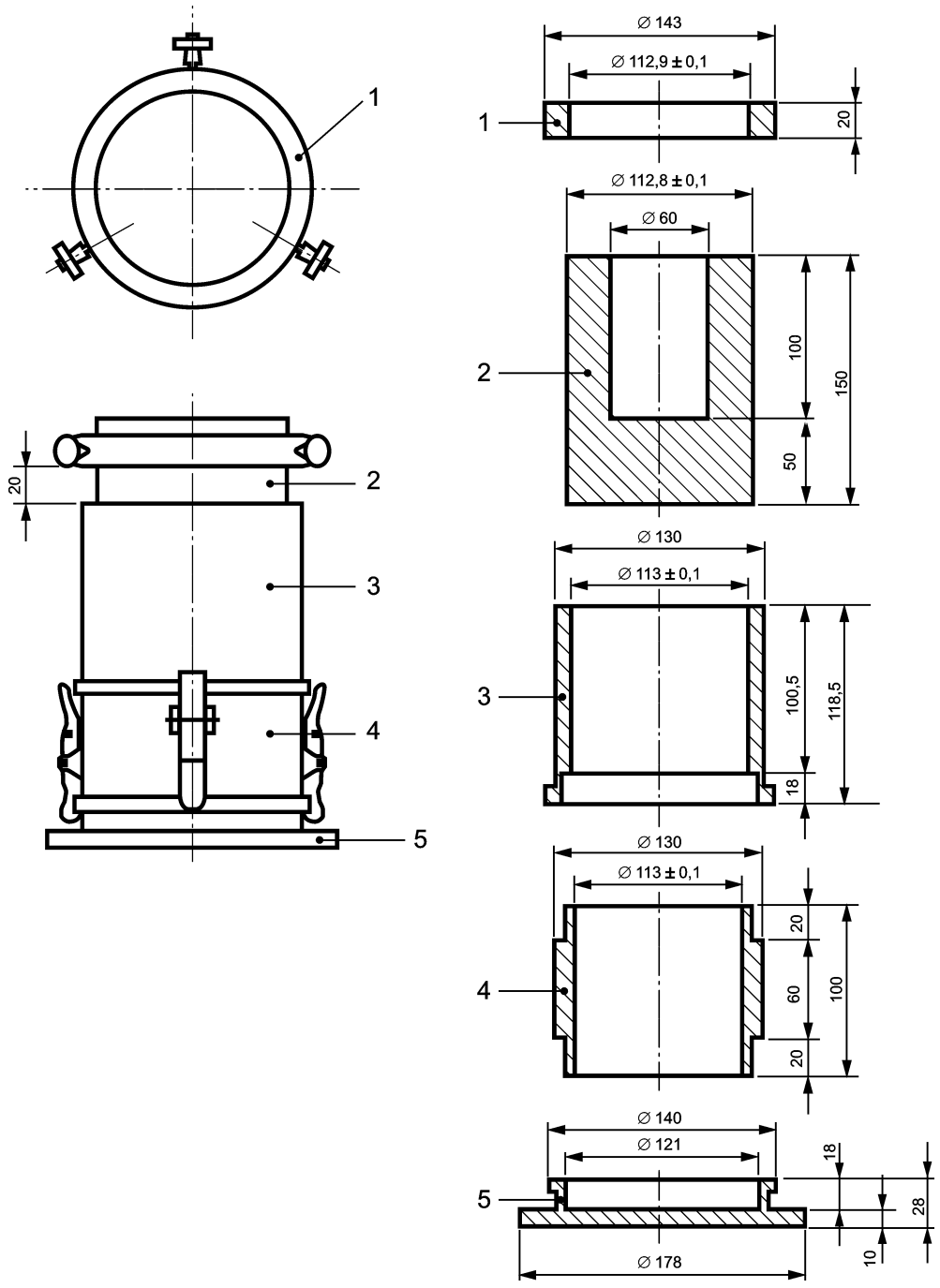
e) date of test;

f) mean crushing resistance (C_a or C_b);

g) range of the three test results;

h) duration of vibration.

Dimensions in mm



Key

1 adjustable height ring

2 piston

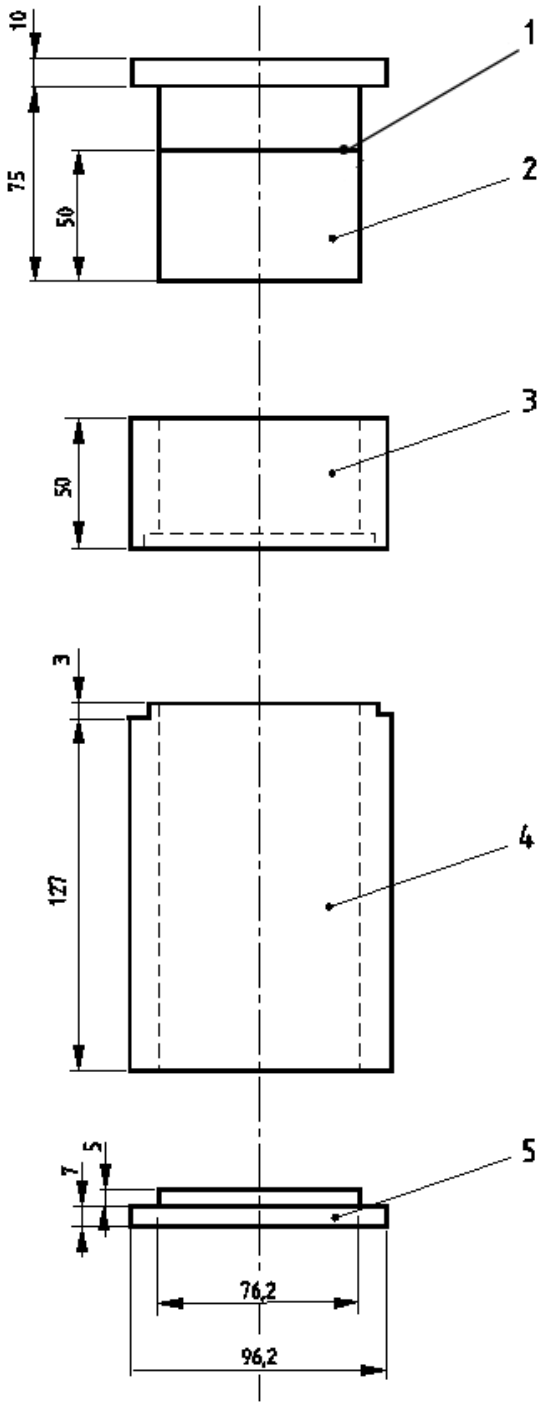
3 upper cylinder

4 lower cylinder

5 base

Figure C.1 — Test apparatus for procedure 1

Dimensions in mm



Key

1 mark 50 mm
2 piston
3 collar
4 cylinder
5 base

Figure C.2 — Test apparatus for procedure 2

Annex D
(informative)

Determination of water absorption for fine LWA

D.1 General

This informative Annex D describes a method for the determination of the water absorption of fine LWA since this is not covered by EN 1097-6.

This Annex D (informative) could form the basis of a future stand-alone test method.

D.2 Principle

The test specimen of fine LWA is dried, mixed with water and filtered in a Büchner funnel and a vacuum pump is used to give a surface dry product. The water absorbed is expressed as a percentage of the dry weight.

This test procedure requires the creation of a vacuum in the range of 50 – 100 mbar.

NOTE If the fines content of the LWA test specimen is insufficient to maintain the vacuum required, the coarse fraction will preferably be removed and tested using EN 1097-6.

D.3 Apparatus

D.3.1 General

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

D.3.2 Apparatus for general purposes

D.3.2.1 Balance; accurate to 0,1 g.

D.3.2.2 Ventilated oven, thermostatically controlled to maintain a temperature of (110 ± 5) °C.

D.3.2.3 Timer.

D.3.3 Special apparatus for surface drying

D.3.3.1 Büchner funnel, with diameter of 150 mm and minimum 60 mm height.

D.3.3.2 Erlenmeyer flask with tap for the Büchner funnel.

D.3.3.3 Filter paper of type, Ø 150 mm-range for filtration speed from 10 to 25 s (Herzberg).

D.3.3.4 Glass rod or spatula for stirring in the Büchner funnel. The length should be greater than the depth of the Büchner funnel.

D.3.3.5 Vacuum pump able to maintain a vacuum of 50 to 100 mbar with wet filter only (without sample) and the same range of vacuum at the end of the test (with wet sample).

D.3.3.6 Connection hoses.

D.3.3.7 Manometer or gauge to measure the vacuum.

D.4 Preparation of test specimens

Sampling of the LWA shall be in accordance with EN 932-1 and reduction shall be in accordance with EN 932-2.

Prepare two test specimens of the fine LWA with a volume of 400 - 600 ml. Dry the test specimens in accordance with EN 1097-5 and allow to cool to room temperature. When required allow the test specimens to condition to moisture equilibrium at 23 (± 5) °C and 50 (± 10) % relative humidity.

D.5 Test procedure

Place a filter paper in the Büchner funnel and soak with water. Allow to drain. Weigh the Funnel and wet filter paper to the nearest 0,1 g and record as M_1. Transfer a test specimen into the Funnel and reweigh as M_2.

Assemble the Büchner funnel with test specimen on the flask and connect to the hose, pump and vacuum gauge.

Fill the Büchner funnel quickly and carefully with the water, while stirring the test specimen. Take care not to damage or lift the filter paper and continue stirring until the entire test specimen is wet.

Start the timer when water is added and allow test specimen to soak in water for 5 min adding more water if required. .

Start the pump after the soaking time and drain away the water for 5 min, maintaining the vacuum in the range of 50 – 100 mbar. The sample should appear surface dry after 5 min.

Reweigh the Büchner funnel wet filter paper and the water saturated, but surface dry, test specimen to nearest 0,1 g. Record as M_3 (t).

Repeat the procedure for the second test specimen.

The water absorption can be measured for other soaking times if required. Record the soaking time as t.

D.6 Calculation and expression of results

Calculate the water absorption at the given soaking time, WA(t), as a percentage of dry specimen mass in accordance with the following formula:

$$WA(t) = \frac{(M_3(t) - M_2)}{(M_2 - M_1)} \times 100$$

where

WA(t) is the water absorption at time t, in %;

M_1 is the mass of the Büchner funnel with wet filter paper, in grams;

M_2 is the mass of the Büchner funnel with wet filter paper and dry test specimen, in grams;

$M_3(t)$ is the mass of the Büchner funnel with wet filter paper and water saturated and surface dry test specimen at soaking time t, in grams.

Calculate the mean value of the two individual water absorption values at the same soaking time. Express the mean value to the nearest 1 %.

D.7 Test report

The test report shall include the following information:

a) reference to Annex D of this European Standard;

b) identification of the sample;

c) identification of the test laboratory;

d) date of test;

e) size fraction of the aggregate tested to this Annex D;

f) if relevant, size fraction and percentage by mass of any aggregate tested according to EN 1097-6;

g) mass of dry sample tested;

h) water absorption of fraction tested according to this Annex D at appropriate soaking times;

i) if relevant, water absorption of any aggregate tested according to EN 1097-6 at appropriate soaking times.

Annex E
(informative)

Guidance on how to convert quantities by mass to quantities by volume

E.1 Background

Limiting values of chemical contents are based on normal weight aggregates with a loose bulk density of approximately 1500 kg/m³ (1,500 Mg/m³).

Chemical contents determined in accordance with EN 1744-1 are expressed as a percentage on a mass basis.

For lightweight aggregate such a test value needs to be corrected before comparing it with the limiting value to allow for the low loose bulk density of lightweight aggregate.

Thus, an aggregate with a loose bulk density of 750 kg/m³ (0,750 Mg/m³) could contain twice the amount of a specific material on a mass by mass basis than could an aggregate having a loose bulk density of 1500 kg/m³ (1,500 Mg/m³) and still comply with the limiting value per cubic metre of concrete.

E.2 Example calculation

The limiting value for an application is 0,01 % mass by mass.

The proposed aggregate has a loose bulk density of 750 kg/m³ (0,750 Mg/m³).

The chemical content measured according to EN 1744-1 (say C_n) is 0,018 % mass by mass.

The comparison value is then:

$$C_n = 0{,}018\frac{750}{1500} = 0{,}009$$

The comparison value of 0,009 % is less than the limit value of 0,01 %.

The proposed aggregate is therefore suitable for its intended application.

Annex F
(informative)

Guidance on the effects of some chemical constituents of LWA on the durability of concrete, mortar and grout in which they are incorporated

F.1 General

Lightweight aggregates should not contain substances in quantities and forms that adversely affect the suitability for their intended use.

F.2 Chlorides

Chlorides can be present in LWA. To minimise the risk of corrosion of embedded metal it is usual to limit the amount of chlorides in concrete and mortar contributed from all constituents.

F.3 Organic components

F.3.1 Two screening tests for the presence of organic matter are in common use: the sodium hydroxide test and the fulvo acid test. If the supernatant liquid in these tests is lighter than the standard colours when determined in accordance with EN 1744-1, the aggregate can be considered to be free from organic matter (see F.3.5).

NOTE Some inorganic compounds which discolour the supernatant liquid in the sodium hydroxide test do not adversely affect the setting and hardening of concrete/mortar.

F.3.2 Aggregates that contain organic or other substances in proportions which alter the rate of setting and hardening of concrete/mortar should be quantitatively assessed for the presence of such materials. The effect on stiffening time and compressive strength should be determined in accordance with EN 1744-1.

The proportions of such materials should be such that compliance with F.3.3 and F.3.4 is ensured.

F.3.3 The increase of the stiffening time of concrete/mortar test specimens should not be more than 120 min.

F.3.4 The decrease of the compressive strength of concrete/mortar test specimen should not be more than 20 %.

F.3.5 Sugars do not affect the colour of the supernatant liquid in the sodium hydroxide test or the fulvo acid test. If it is suspected that sugars or sugar type materials are present, the aggregate should be tested using the concrete/mortar specimen test specified in EN 1744-1. The stiffening time and compressive strength requirements given in F.3.3 and F.3.4 should apply.

F.4 Alkali aggregate reaction

F.4.1 General

Certain aggregates can react with alkalis present in the pore fluids of concrete, mortar and grout. Under adverse conditions and in the presence of moisture this can lead to expansion and subsequent cracking or disruption of the concrete, mortar and grout. The most common form of reaction occurs between

alkalis and certain form of silica (alkali-silica reaction). Another much less common form of reaction is alkali-carbonate reaction.

F.4.2 In the absence of previous long-term experience of a lack of disruptive reactivity of a particular combination of cement and aggregate, it may be necessary to take account of the following precautions:

a) limit the total alkali content of the concrete/mortar mix;

b) use a cement with a low effective alkali content;

c) use a non-reactive aggregate combination;

d) limit the degree of saturation of the concrete/mortar with water.

F.4.3 The combination of aggregate and cement should be assessed using procedures described in regulations valid in the place of use only when compliance with one of the above procedures is not possible.

F.5 Sulphates

Sulphates in LWA can give rise to expansive disruption of the concrete. Under certain circumstances, other sulphur compounds present in the LWA can oxidize in the concrete to produce sulphates. These can also give rise to expansive disruption of concrete.

Annex G
(informative)

Indicative test frequencies for factory production control (FPC)

Table G.1 — Indicative test frequencies for FPC

Characteristic		Clause	Notes	Test method	If declared – indicative test frequencies
1	Loose bulk density	5.2.1		EN 1097-3	1 per day or 1 per 1 000 m^3
2	Particle density	5.2.2		EN 1097-6	1 per month or 1 per 20 000 m^3
3	Grading	5.4		EN 933-1	1 per week or 1 per 5 000 m^3
4	Fines content in LWA	5.5		EN 933-1	1 per week or 1 per 5 000 m^3
5	Grading of lightweight filler aggregate	5.6		EN 933-10	1 per week
6	Water content	5.8		EN 1097-5	1 per day or 1 per 1 000 m^3
7	Water absorption	5.9		EN 1097-6 and/or Annex D	1 per month or 1 per 20 000 m^3
8	Bulk crushing resistance	5.10		Annex C	1 per month or 1 per 20 000 m^3
9	Resistance to	5.12	Only to be determined in the absence of long term experience	EN 1367-8	2 per year
10	Freezing and thawing resistance	5.13	Only to be determined in the absence of long term experience	EN 1367-7	2 per year
11	Water suction height	5.14		EN 1097-10	1 per month or 1 per 20 000 m^3
12	Compressibility and confined compressive strength	5.15		EN 1097-11	1 per 2 years
13	Resistance to cyclic compressive loading	5.16		EN 13286-7	1 per 3 years
14	Stiffening properties	5.17	Fillers in mixtures only	EN 13179-1	2 per year
15	Voids of dry compacted lightweight filler aggregate	5.18		EN 1097-4	2 per year

16	Resistance to thermal shock	5.19		EN 1367-5	1 per 2 years
17	Resistance to polishing	5.20	Resistance to polishing of coarse aggregate for surface courses only	EN 1097-8	1 per 2 years
18	Resistance to wear by an abrasion from studded tyres of coarse LWA in surface treatments	5.21	Aggregate for surface courses only	EN 1097-9	When required and in case of doubt
19	Affinity between LWA and bitumen	5.22	Only determined in the absence of long term experience	EN 12697-11	When required and in case of doubt
20	Resistance to fragmentation	5.23	Aggregates for surface courses only	EN 1097-2	1 per year
21	Resistance to wear	5.24	Aggregates for surface courses only	EN 1097-1	1 per year
22	Water solubility	5.25.2	Fillers in bituminous mixtures only	EN 1744-1	1 per 2 years
23	Chloride	5.25.3		EN 1744-1	2 per year
24	Acid soluble sulphate	5.25.4.1.		EN 1744-1	2 per year
25	Total sulphur	5.25.4.2.		EN 1744-1	2 per year
26	Loss on ignition	5.25.5.	For LD source materials (ashes) only	EN 1744-1	2 per year
27	Water soluble constituents	5.25.6		EN 1744-3	1 per 2 years
28	Organic contaminators	5.25.7.		EN 1744-1	2 per year
29	Alkali-silica reactivity	5.25.8.			When required and in case of doubt
30	Thermal conductivity	5.27		EN 12664 or EN 12667	1 per year
31	Dangerous substances	5.26	National provisions in the place of use		When required and in case of doubt

NOTE Consideration of the following points may be useful in determining appropriate FPC test frequencies:

- highly automated production equipment;
- long-term experience with consistency of special properties;
- sources of high conformity;
- running a Quality Management System with exceptional measures for surveillance and monitoring of the production process.

Annex ZA
(informative)

Relationship of this European Standard with Regulation (EU) No 305/2011

(When applying this standard as a harmonized standard under Regulation (EU) No 305/2011, the manufacturers and Member States are obliged to use this annex)

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under standardization request M 125 'Aggregates' (as amended) given to CEN and CENELEC by the European Commission (EC) and the European Free Trade Association (EFTA).

When this European Standard is cited in the Official Journal of the European Union (OJEU), under Regulation (EU) No 305/2011, it shall be possible to use it as a basis for the establishment of the Declaration of Performance (DoP) and the CE marking from the date of the beginning of the co-existence period as specified in the OJEU.

Regulation (EU) No 305/2011, as amended, contains provisions for the DoP and the CE marking.

Table ZA.1.1 — Relevant clauses for LWA for concrete, mortar and grout

Product: Lightweight aggregates (LWA) **Intended use:** Concrete, mortar and grout for buildings, the manufacturing of precast concrete products, roads and other civil engineering			
Essential Characteristics	**Clauses of this European Standard related to essential characteristics**	**Classes and/or threshold levels**	**Notes**
Particle shape, size and density	5.2.1 Loose bulk density	-	Declared value
	5.2.2 Particle density	-	Declared value
	5.3 Aggregate size	-	Declared with designation (d/D)
	5.4 Grading	-	Declared distribution
	5.7 Particle shape	-	Description
Water absorption	5.9 Water absorption	-	Declared value
Resistance to fragmentation/crushing	5.10 Bulk crushing resistance	-	Declared value
Percentage of crushed particles	5.11 Crushed particles	-	Description
Volume stability	5.12 Resistance to disintegration	-	Declared value
Durability against freeze/thaw	5.13 Freezing and thawing resistance	-	Declared value
Composition/content	5.25.3 Chloride	-	Declared value
	5.25.4.1 Acid-soluble sulphate	-	Declared value
	5.25.4.2 Total sulphur	-	Declared value
Cleanliness	5.25.7 Organic contaminators	Threshold	Pass
Durability against alkali-silica reactivity	5.25.8 Alkali-silica reactivity	-	Provisions valid in the place of use
Release of dangerous substances	5.26 Dangerous substances	-	Provisions valid in the place of use

Table ZA.1.2 — Relevant clauses for LWA fillers for concrete, mortar and grout

Product: Lightweight aggregate (LWA) fillers **Intended use:** Concrete, mortar and grout for buildings, the manufacturing of precast concrete products, roads and other civil engineering works			
Essential Characteristics	**Clauses of this European Standard related to essential characteristics**	**Classes and/or threshold levels**	**Notes**
Fineness/Particle size and density	5.2.1 Loose bulk density	-	Declared value
	5.6 Grading of LWA filler	-	Declared distribution
Volume stability	5.12 Resistance to disintegration	-	Declared value
Durability against freeze/thaw	5.13 Freezing and thawing resistance	-	Declared value
Composition/content	5.25.3 Chloride	-	Declared value
	5.25.4.1 Acid-soluble sulphate	-	Declared value
	5.25.4.2 Total sulphur	-	Declared value
Loss on ignition (for ashes only)	5.25.5 Loss on ignition	-	Declared value
Cleanliness	5.25.7 Organic contaminators	Threshold	Pass
Durability against alkali-silica reactivity	5.25.8 Alkali-silica reactivity	-	Provisions valid in the place of use
Release of dangerous substances	5.26 Dangerous substances	-	Provisions valid in the place of use

Table ZA.1.3 — Relevant clauses for LWA for bituminous mixtures and surface treatments

Product: Lightweight aggregates (LWA) **Intended use:** Bituminous mixtures and surface treatments for buildings, roads and other civil engineering works			
Essential Characteristics	**Clauses of this European Standard related to essential characteristics**	**Classes and/or threshold levels**	**Notes**
Particle shape, size and density	5.2.1 Loose bulk density	-	Declared value
	5.2.2 Particle density	-	Declared value
	5.3 Aggregate size	-	Declared with designation (d/D)
	5.4 Grading	-	Declared distribution
	5.7 Particle shape	-	Description
Resistance to fragmentation/crushing	5.10 Bulk crushing resistance	-	Declared value
	5.23 Resistance to fragmentation	-	Declared value
Percentage of crushed particles	5.11 Crushed particles	-	Description
Volume stability	5.12 Resistance to disintegration	-	Declared value
Durability against freeze/thaw/weathering	5.13 Freezing and thawing resistance	-	Declared value
Resistance to thermal shock	5.19 Resistance to thermal shock	-	Declared value
Resistance to polishing / abrasion / wear / attrition	5.20 Resistance to polishing	-	Declared value
	5.21 Resistance to wear by abrasion from studded tyres of coarse LWA in surface treatments	-	Declared value
	5.24 Resistance to wear	-	Declared value
Affinity to bituminous binders	5.22 Affinity between LWA and bitumen	-	Declared value
Composition/content	5.25.3 Chloride	-	Declared value
	5.25.4 Sulphur containing compounds	-	Declared value
Cleanliness	5.25.7 Organic contaminators	Threshold	Pass
Release of dangerous substances	5.26 Dangerous substances	-	Provisions valid in the place of use

Table ZA.1.4 — Relevant clauses for LWA fillers for bituminous mixtures and surface treatments

Product: Lightweight aggregate (LWA) fillers **Intended use:** Bituminous mixtures and surface treatments for buildings, roads and other civil engineering works			
Essential Characteristics	**Clauses of this European Standard related to essential characteristics**	**Classes and/or threshold levels**	**Notes**
Fineness/Particle size and density	5.2.1 Loose bulk density 5.6 Grading of LWA filler	- -	Declared value Declared distribution
Durability against freeze/thaw/weathering	5.13 Freezing and thawing resistance	-	Declared value
Stiffening properties	5.17 Stiffening properties	-	Declared value
Porosity/volume of voids	5.18 Voids of dry compacted LWA filler	-	Declared value
Water solubility	5.25.2 Water solubility	-	Declared value
Loss on ignition (for ashes only)	5.25.5 Loss on ignition	-	Declared value
Cleanliness	5.25.7 Organic contaminators	Threshold	Pass
Release of dangerous substances	5.26 Dangerous substances	-	Provisions valid in the place of use

Table ZA.1.5 — Relevant clauses for LWA for unbound and hydraulically bound applications

Product: Lightweight aggregates (LWA) **Intended use:** Unbound and hydraulically bound applications for buildings, roads and other civil engineering works			
Essential Characteristics	**Clauses of this European Standard related to essential characteristics**	**Classes and/or threshold levels**	**Notes**
Particle shape, size and density	5.2.1 Loose bulk density	-	Declared value
	5.2.2 Particle density	-	Declared value
	5.3 Aggregate size	-	Declared with designation (d/D)
	5.4 Grading	-	Declared distribution
	5.7 Particle shape	-	Description
Water absorption/suction	5.9 Water absorption	-	Declared value
	5.14 Water suction height	-	Declared value
Percentage of crushed particles	5.11 Crushed particles	-	Description
Volume stability	5.12 Resistance to disintegration	-	Declared value
Durability against freeze/thaw/weathering	5.13 Freezing and thawing resistance	-	Declared value
Resistance to fragmentation/ crushing	5.15 Compressibility and confined compressive strength	-	Declared value
	5.16 Resistance to cyclic compressive loading	-	Declared value
Composition/content	5.25.3 Chloride	-	Declared value
	5.25.4 Sulphur containing compounds	-	Declared value
Cleanliness	5.25.7 Organic contaminators	Threshold	Pass
Release of dangerous substances:	5.26 Dangerous substances	-	Provisions valid in the place of use

ZA.2 System of Assessment and Verification of Constancy of Performance (AVCP)

The AVCP systems of lightweight aggregates (LWA) and LWA fillers indicated in Tables ZA.1.1 to ZA.1.5 can be found in the EC legal acts adopted by the EC: Commission Decision 98/598/EC of 9 October 1998 (OJEU L 287 of 24 October 1998, p. 25–29) amended by the Commission Decision 2002/592/EC of 15 July 2002 (OJEU L192 of 20 July 2002, p. 57–59).

Micro-enterprises are allowed to treat products under AVCP system 3 covered by this standard in accordance with AVCP system 4, applying this simplified procedure with its conditions, as foreseen in Article 37 of Regulation (EU) No.305/2011.

ZA.3 Assignment of AVCP tasks

The AVCP of lightweight aggregates (LWA) and LWA fillers as provided in Tables ZA.1.1 to ZA.1.5 is defined in Tables ZA.3.1 to ZA.3.2 resulting from application of the clauses of this or other European Standards indicated therein. The content of the tasks assigned to the notified body shall be limited to those essential characteristics, if any, as provided for in Annex III of the relevant standardization request and to those that the manufacturer intends to declare.

Taking into account the AVCP systems defined for the products and the intended uses the following tasks are to be undertaken by the manufacturer and the notified body respectively for the assessment and verification of the constancy of performance of the product.

Table ZA.3.1— Assignment of AVCP tasks for lightweight aggregates (LWA) and LWA fillers under system 2+ (for uses with high safety requirements [1])

Tasks		Content of the task	AVCP clauses to apply
Tasks for the manufacturer	An assessment of the performance of the construction product carried out on the basis of testing (including sampling), calculation, tabulated values or descriptive documentation of the product	Essential characteristics of Tables ZA.1.1 to ZA.1.5 relevant for the intended use(s) which are declared	7.2
	Factory production control (FPC)	Parameters related to essential characteristics of Tables ZA.1.1 to ZA.1.5 relevant for the intended use(s) which are declared	7.3.1 7.3.2 7.3.3
	Further testing of samples taken at the manufacturing plant by the manufacturer in accordance with the prescribed test plan.	Essential characteristics of Tables ZA.1.1 to ZA.1.5 relevant for the intended use(s) which are declared	7.3.3
Tasks for the notified production control certification body	Initial inspection of the manufacturing plant and of FPC	Parameters related to essential characteristics of Tables ZA.1.1 to ZA.1.5 relevant for the intended use(s) which are declared. Documentation of the FPC.	7.3.4
	Continuous surveillance, assessment and evaluation of FPC	Parameters related to essential characteristics of Tables ZA.1.1 to ZA.1.5 relevant for the intended use(s) which are declared. Documentation of the FPC.	7.3.5

Table ZA.3.2 — Assignment of AVCP tasks for lightweight aggregates (LWA) and LWA fillers under system 4 (for uses without high safety requirements [1])

Tasks		Content of the task	AVCP clauses to apply
Tasks for the manufacturer	An assessment of the performance of the construction product on the basis of testing, calculation, tabulated values or descriptive documentation of that product	Essential characteristics of Tables ZA.1.1 to ZA.1.5 relevant for the intended use(s) which are declared	7.2
	Factory production control (FPC)	Parameters related to essential characteristics of Tables ZA.1.1 to ZA.1.5 relevant for the intended use(s) which are declared	7.3.1 7.3.2 7.3.3

[1] Safety requirements are to be defined by Member States in their national laws, regulations and administrative provisions.

The products and intended uses defined in Tables ZA.1.1 to ZA.1.5 can belong to both AVCP systems cited above in Tables ZA.3.1 and ZA.3.2. The AVCP system selection for the relevant Table ZA.1.1 to ZA.1.5 will depend only on the high safety requirement (with or without).

Bibliography

[1] M 125 (CEN/TC 154/N 502), *Mandate to CEN/CENELEC concerning the execution of standardisation work for harmonized standards on aggregates (6 July 1998)*

[2] EuroLightCon R15 (CEN/TC 154/SC 5/N 529), *European Union — Brite EuRam III — Light Weight Aggregates (June 2000)*

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

[4] EN ISO 9001, *Quality management systems — Requirements (ISO 9001)*

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