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English Version

Tests for geometrical properties of aggregates - Part 8: Assessment of fines - Sand equivalent test

Essais pour déterminer les caractéristiques géométriques des granulats - Partie 8 : Évaluation des fines - Équivalent de sable

Prüfverfahren für geometrische Eigenschaften von Gesteinskörnungen - Teil 8: Beurteilung von Feinanteilen - Sandäquivalent-Verfahren

This European Standard was approved by CEN on 6 November 2011 and includes Amendment 1 approved by CEN on 20 April 2015.

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

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Ref. No. EN 933-8:2012+A1:2015 E

Contents

Page

Foreword

This document (EN 933-8:2012+A1:2015) 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of an identical text or by endorsement, at the latest by November 2015, and conflicting national standards shall be withdrawn at the latest by November 2015.

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 ⟦A1⟩ EN 933-8:2012 ⟨A1⟧.

This document includes Amendment 1 approved by CEN on 2015-04-19.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ⟦A1⟩ ⟨A1⟧.

This revised standard differs from EN 933-8:1999 for 0/2 mm size aggregates where the fines content was not limited to 10 %.

This European Standard is one of a series of standards for tests for geometrical properties of aggregates. Test methods for other properties of aggregates are covered by the following European Standards:

— EN 932, Tests for general properties of aggregates;

— EN 1097, *Tests for mechanical and physical properties of aggregates;*

— EN 1367, *Tests for thermal and weathering properties of aggregates;*

— EN 1744, *Tests for chemical properties of aggregates;*

— EN 13179, *Tests for filler aggregate used in bituminous mixtures.*

The other parts of EN 933, *Tests for geometrical properties of aggregates*, will be:

— *Part 1: Determination of particle size distribution — Sieving method;*

— *Part 2: Determination of particle size distribution — Test sieves, nominal size of apertures;*

— *Part 3: Determination of particle shape — Flakiness index;*

— *Part 4: Determination of particle shape — Shape index;*

— *Part 5: Determination of percentage of crushed and broken surfaces in coarse aggregate particles;*

— *Part 6: Assessment of surface characteristics — Flow coefficient of aggregates;*

— *Part 7: Determination of shell content — Percentage of shells in coarse aggregates;*

— *Part 9: Assessment of fines — Methylene blue test;*

— *Part 10: Assessment of fines — Grading of filler aggregates (air jet sieving);*

— *Part 11: Classification test for the constituents of coarse recycled aggregate*.

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 describes the reference method used for type testing and in case of dispute for the determination of the sand equivalent value of 0/2 mm fraction (for 0/4 mm, see Annex A) in fine aggregates or all-in aggregates. For other purposes, in particular factory production control, other methods may be used provided that an appropriate working relationship with the reference method has been established.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 932-2, *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 933-2, *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.

3.1
fines
particle size fraction of an aggregate which passes the 0,063 mm sieve

3.2
laboratory sample
sample intended for laboratory testing

3.3
particle size fraction (d_i/D_i)
fraction of an aggregate passing the larger (D_i) of two sieves and retained on the smaller (d_i)

NOTE The lower limit d_i may be zero.

3.4
subsample
sample obtained by means of a sample reduction procedure

3.5
test portion
sample used as a whole in a single test

3.6
test specimen
sample used in a single determination when a test method requires more than one determination of a property

4 Principle

A 0/2 mm test specimen of aggregate with a maximum fines content of 10 % (either natural or obtained after grading curve adjustment) and a small quantity of washing and flocculating solution are poured into a graduated cylinder and are agitated to loosen the clay coatings from the coarser particles in the test portion. The aggregate is then 'irrigated' using additional washing and flocculating solution forcing the fine particles into suspension. After a fixed time, the sand equivalent value (*SE(10)*) is calculated as the height of sediment expressed as a percentage of the total height of sediment and suspension in the cylinder.

5 Reagents

5.1 Concentrated solution, made up of:

a) crystalline calcium chloride, $CaCl_2.6H_2O$ or anhydrous calcium chloride, $CaCl_2$;

b) glycerine, 99 % glycerol, laboratory reagent quality;

c) formaldehyde solution, 40 % by volume, laboratory reagent quality;

d) distilled or demineralised water.

Dissolve (219 ± 2) g of crystalline calcium chloride in (350 ± 50) ml of distilled or demineralised water, cool to room temperature and if necessary filter through a medium or coarse grade filter paper. Add (480 ± 5) g of glycerine and (12,5 ± 0,5) g of formaldehyde solution and dilute to 1 l of solution with distilled or demineralised water and mix thoroughly.

NOTE 1 219 g $CaCl_2.6H_20$ $6H_2O$ is equivalent to 111 g anhydrous calcium chloride $CaCl_2$.

NOTE 2 It is recommended that the concentrated solution is stored protected from light in glass or plastics flasks containing (125 ± 1) ml.

NOTE 3 Sodium hypochlorite (bleach) with 2,6 % active chloride can be used instead of formaldehyde. In case of dispute, use formaldehyde.

5.2 Washing and flocculating solution, prepared by diluting (125 ± 1) ml concentrated solution (5.1) to (5,00 ± 0,01) l using distilled or demineralised water.

NOTE In preparing the washing solution, the concentrated solution should first be vigorously shaken and subsequently its container should be rinsed several times using distilled or demineralised water, pouring the rinsing water into the 5 l flask before diluting to 5 l.

Washing solution shall not be used more than 28 days after preparation or if it is cloudy or contains any precipitate or mould.

6 Apparatus

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

6.2 Two graduated cylinders, of glass or clear plastic (see Figure 1) complete with rubber bungs and with the following dimensions:

a) wall thickness, about 3 mm;

b) inside diameter (32,0 ± 0,5) mm;

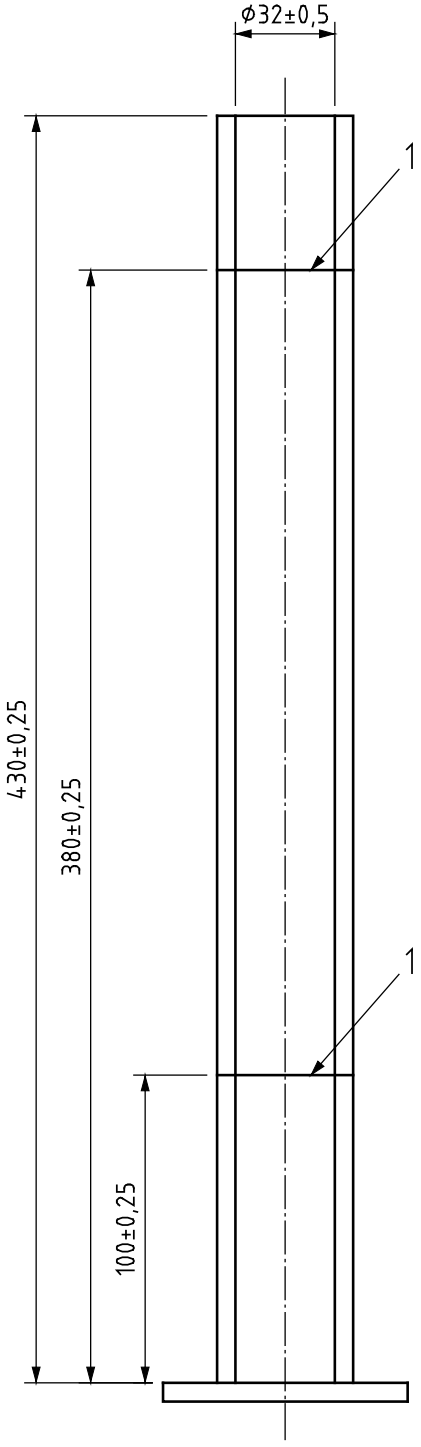
c) height (430,00 ± 0,25) mm.

Each cylinder shall be clearly marked in two positions:

d) at (100,00 ± 0,25) mm from the base; and

e) at (380,00 ± 0,25) mm from the base.

Dimensions in millimetres



1 Circle mark

Figure 1 — Graduated cylinder

6.3 Test plunger assembly (see Figure 2) comprising:

a) a rod (440,00 ± 0,25) mm long;

b) an end piece (25,0 ± 0,1) mm diameter, its lower surface being flat, smooth and perpendicular to the rod axis and which includes three guides at the side for centring the plunger in the cylinder, leaving a small clearance;

c) a collar, (10,0 ± 0,1) mm thick, suitable for use with the graduated cylinder, acting as a guide for the rod and, at the same time, used to indicate the distance the test plunger is inserted inside the cylinder; the collar shall include a screw which enables it to be locked onto the rod of the test plunger and the collar shall also have a slot for a rule;

d) a plunger head, fixed to the upper end of the rod, to give the test plunger assembly, excluding the collar, a total mass of (1,00 ± 0,01) kg.

The immersed parts of the plunger assembly shall be made from non-corrodible metal.

NOTE Before first use of a test plunger or a graduated cylinder, the plunger assembly should be placed in the empty cylinder. With the collar resting on the rim of the cylinder, the distance between the upper face of the collar and the lower face of the plunger head should not exceed 0,5 mm. If this clearance exceeds 0,5 mm or if the end piece does not reach the bottom of the cylinder, this combination of test plunger and graduated cylinder should not be used.

6.4 Stop clock(s), readable to 1 s.

6.5 500 mm rule, graduated in millimetres.

6.6 Test sieves, 0,063 and 2 mm conforming to EN 933-2 with, if necessary, a guard sieve.

6.7 Sieve brush.

6.8 Spatula.

6.9 Washing tube (see Figure 3), comprising a rigid tube of non-corrodible metal with the following dimensions:

a) outside diameter (6,0 ± 0,5) mm;

b) inside diameter (4,0 ± 0,2) mm;

c) length about 500 mm.

The washing tube shall be fitted with a tap at the top. The bottom end of the tube (see Figure 4) shall be conical or wedge-shaped, made from non-corrodible metal and have a threaded (screw) connection. A hole (1 ± 0,1) mm diameter shall be made diametrically in each angled face.

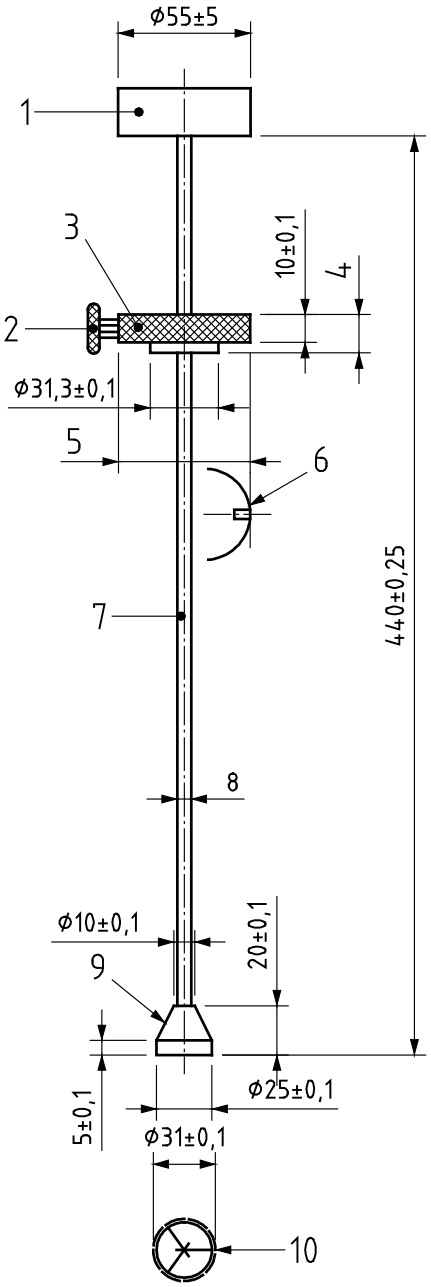
NOTE The tolerances on the washing tube are for manufacturing purposes.

6.10 Flask of glass or clear plastic of 5 l capacity fitted with a siphon system, its base being positioned about 1 m above the work bench.

6.11 Rubber or plastic tube, of length approximately 1,50 m, and inside diameter approximately 5 mm, connecting the washing tube to the siphon.

6.12 Funnel, for transferring the test portion into the graduated cylinder (see Figure 5).

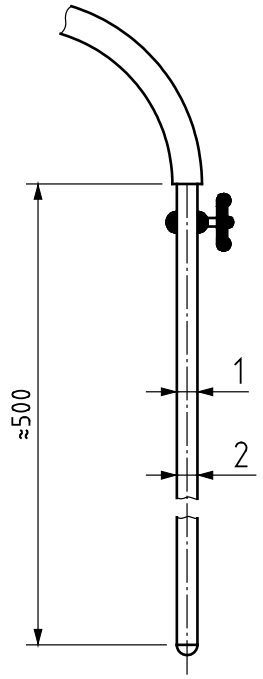
Dimensions in millimetres



1. Plunger head dimensions to give the plunger assembly, excluding collar and its locking screw, a mass of (1 ± 0,01) kg
2. Locking screw
3. Collar
4. 15 approx.
5. Ø 60 approx.
6. Slot for rule
7. Rod
8. Ø 6 approx.
9. End piece
10. 3 guides

Figure 2 — Test plunger

Dimensions in millimetres

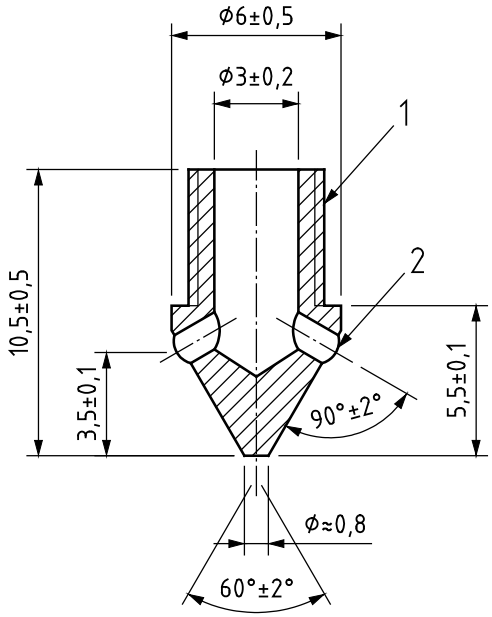


1 Outside diameter 6±0,5

2 Inside diameter 4±0,2

Figure 3 — Washing tube

Dimensions in millimetres



1 Threaded connection to washing tube

2 holes Ø 1 ± 0,1

Figure 4 — Detail end of washing tube

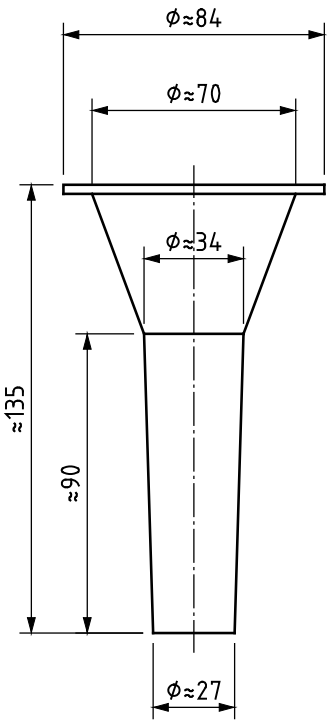


Figure 5 — Funnel

6.13 Shaking machine, capable of imparting to the cylinder a horizontal, rectilinear, periodic and sinusoidal movement of (200 ± 10) mm stroke, at a frequency of one-third of a second.

6.14 Thermometer, readable to 1 °C.

6.15 Balance, readable to 0,1 % of the mass to be weighed.

6.16 Filter paper, medium or coarse grade.

7 Preparation of test specimens

7.1 General

The laboratory sample shall be reduced in accordance with EN 932-2 to obtain two subsamples. The first subsample is used to determine the water content and fines content of the laboratory sample, and to prepare a corrective fine aggregate. The second subsample is used to determine the sand equivalent value.

The test shall be carried out on the 0/2 mm size fraction. The second subsample shall not be artificially dried.

The various steps in the preparation of test specimens are described in detail in 7.2 and 7.3. and summed up in Figure 6.

NOTE If the test portion is taken from an all-in aggregate, the laboratory sample should be sieved at a moisture content less than 2 % on a 2 mm sieve protected by a guard sieve, using a sieve brush to ensure effective separation and collection of all particles in the 0/2 mm fraction.

7.2 First subsample

Further reduce the first subsample in accordance with EN 932-2 to obtain two test portions. Oven dry the first test portion at (110 ± 5) °C in accordance with EN 1097-5, in order to determine and record the water content *w* (percentage of dry mass).

Meanwhile, weigh and record as M_1 the mass of the second test portion, then wash it on the 0,063 mm sieve in accordance with EN 933-1. Dry the particles retained on the 0,063 mm sieve, and weigh and record as M_2.

Determine the fines content *f* according to the following relation:

$$f = 100 - \frac{M_2 (100 + w)}{M_1} (\%) \quad (1)$$

If the fines content of the 0/2 mm size fraction exceeds 10 %, the washed particles retained on the 0,063 mm sieve are used as dry corrective fine aggregate (7.3).

7.3 Second subsample

Further reduce the second subsample in accordance with EN 932-2 to obtain two test specimens.

Depending on the fines content, determine the value of M_T according to one of the following:

1) If the fines content is less than or equal to 10 %, the mass M_T of each test specimen shall be calculated using:

$$M_T = \frac{120(100 + w)}{100} \text{ g (to the nearest gram)} \quad (2)$$

2) Or, if the fines content is above 10 %, M_T shall be calculated using the following relations:

$$M_T = M_3 + M_4 \quad (3)$$

where

M_3 is the mass of moist aggregates taken from the second subsample, calculated using the equation:

$$M_3 = \frac{1200}{f}\left(1 + \frac{w}{100}\right) \text{ ; and}$$

M_4 is the mass of dry corrective fine aggregate, calculated using the equation:

$$M_4 = 120 - \frac{1200}{f}$$

and both materials of masses M_3 and M_4 shall be combined and mixed.

8 Procedure

8.1 General

The test shall be carried out on two test specimens at a temperature of (23 ± 3) °C.

8.2 Filling of the graduated cylinders

Siphon washing solution (5.2) into each graduated cylinder up to the lower mark on the cylinder.

Using the funnel pour a test specimen into each graduated cylinder, holding the cylinder vertical.

Tap the bottom of each cylinder several times, using the palm of the hand, to dislodge air bubbles and to facilitate wetting of the test specimen.

Leave each cylinder for (10 ± 1) min to soak the test specimen.

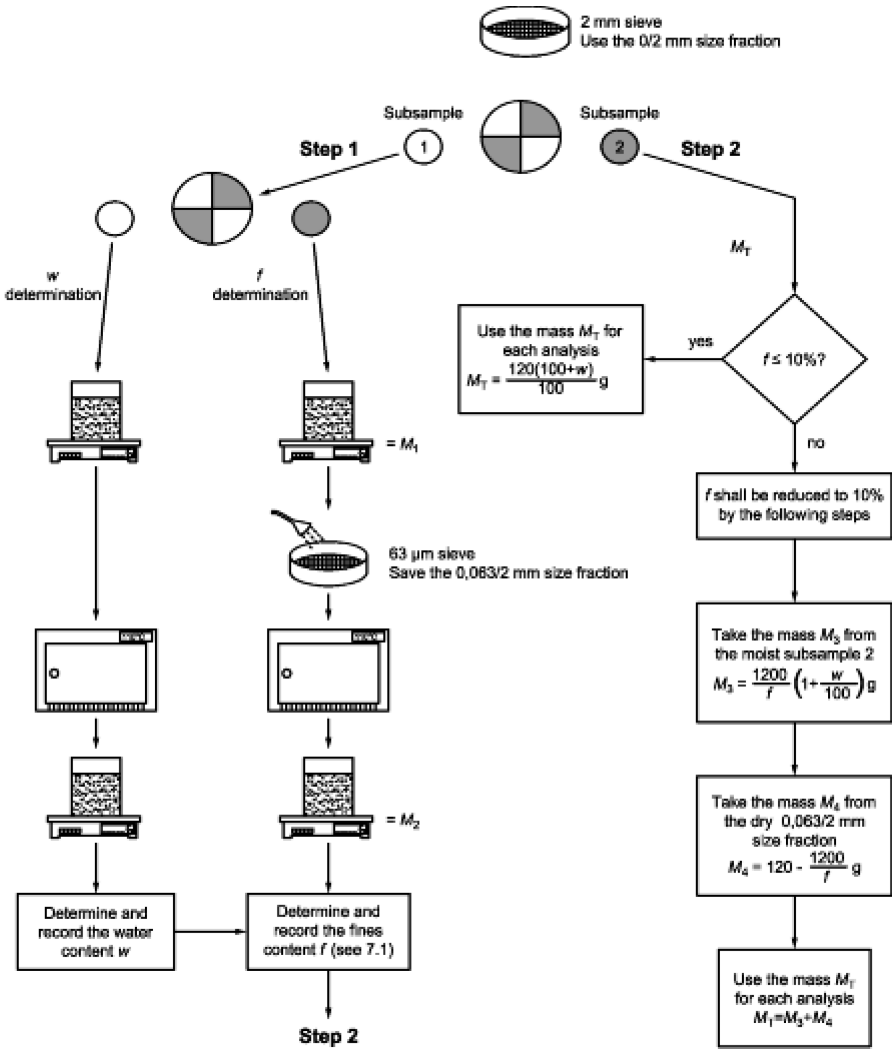


Figure 6 — Flow chart describing the preparation of test specimens

8.3 Shaking the graduated cylinders

At the end of the 10 min period, seal one cylinder using one of the rubber bungs and fix the cylinder onto the shaking machine.

Shake the cylinder for (30 ± 1) s and then replace the cylinder on the test bench, in an upright, vertical position.

NOTE This shaking time should correspond to (90 ± 3) cycles using the apparatus specified in 6.13.

Repeat the shaking procedure with the second cylinder.

8.4 Washing

Remove the rubber bung from one graduated cylinder, and rinse it above the cylinder using the washing solution, ensuring all material is returned to the cylinder.

Insert the washing tube into the cylinder, first rinsing the walls of the cylinder using the washing solution and then push the tube down through the sediment to the bottom of the cylinder.

Hold the cylinder in a vertical position whilst allowing the washing solution to agitate the contents and encourage the fines and clayey components to rise upwards.

Then, while subjecting the cylinder to a slow rotation movement, slowly and regularly raise the washing tube.

When the level of liquid approaches the upper engraved mark slowly lift the washing tube and regulate the flow so as to maintain the level of liquid at the upper mark until the tube has been withdrawn entirely and the flow stopped.

Start to time the settling period immediately on withdrawing the washing tube.

Repeat the washing procedure with the second cylinder.

8.5 Measurements

Leave each graduated cylinder to settle, without disturbance and free from vibration, for (20,00 ± 0,25) min.

At the end of this period, using the rule (6.5), measure the height h_1 of the upper level of the suspension relative to the base of the graduated cylinder (see Figure 7).

Carefully lower the plunger assembly into the cylinder, until the end piece rests on the sediment.

NOTE During this operation, the sliding collar which should not yet be locked onto the plunger rod, will contact the top of the graduated cylinder.

Locate the collar on top of the cylinder and then lock it onto the plunger rod.

Determine the height of sediment h_2 by measuring the distance between the lower face of the plunger head and the upper face of the collar using the graduated rule inserted into the slot in the collar (see Figure 7).

Record the heights h_1 and h_2 to the nearest millimetre.

Measure and record heights h_1 and h_2 in the same manner with the second cylinder.

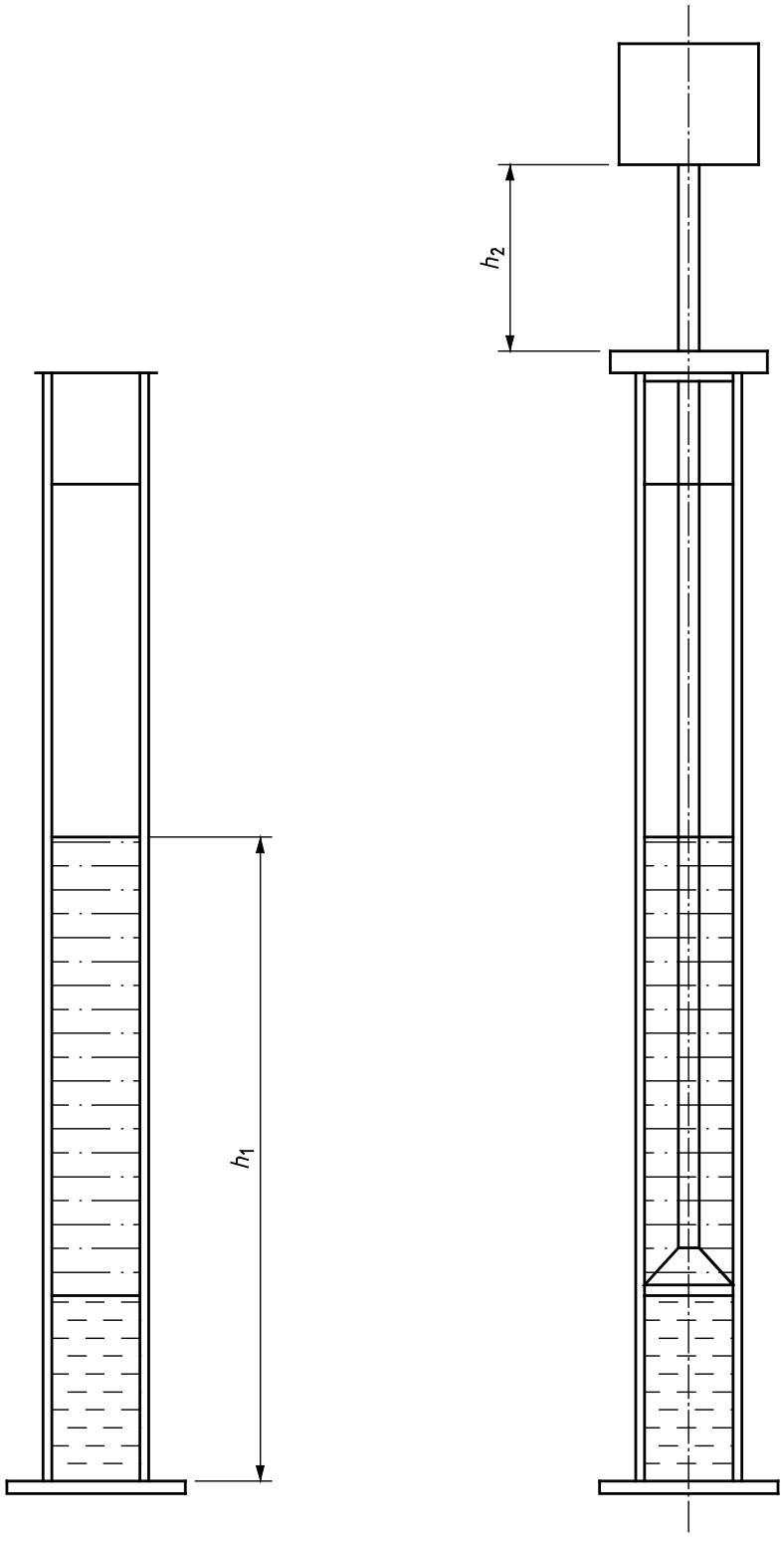


Figure 7 — Measurement of h_1 and h_2

9 Calculation and expression of results

Calculate the ratio $(h_2/h_1) \times 100$ for each cylinder to one decimal place.

If the two values differ by more than 4 the test procedure shall be repeated.

Calculate the sand equivalent value *SE(10)* as the average of the ratios $(h_2/h_1) \times 100$ obtained on each cylinder and record to the nearest whole number.

10 Test report

10.1 Required data

The test report shall include the following information:

a) reference to this European Standard;

b) identity of laboratory;

c) identification of the sample;

d) masses M_1 and M_2;

e) water content *w*;

f) fines content *f*;

g) value of *SE(10)* to the nearest whole number;

h) date of receipt of sample;

i) sampling certificate, if available.

10.2 Optional data

The test report can include the following information.

a) name and location of the sample source;

b) description of the material and of the sample reduction procedure;

c) masses of test specimens;

d) grading of the submitted sample (according to EN 933-1);

e) date of test.

Annex A
(normative)

Procedure for the determination of the sand equivalent value of the 0/4 mm fraction

〈A1〉

A.1 Prepare the test portions and test specimens as specified in Clause 7, but using the 0/4 mm fraction with a moisture content less than 2 %. 〈A1〉

A.2 Follow the test procedure specified in Clause 8 and records heights h_1 and h_2 in each graduated cylinder.

A.3 Calculate the sand equivalent value SE_4 as the average of the ratios (h_2/ h_1) × 100 obtained on each cylinder and record the value to the nearest whole number.

A.4 Test reports shall include appropriate information in accordance with Clause 10 substituting SE_4 for the sand equivalent value in Clause 10.

Annex B
(informative)

Example of a test data sheet

EN 933-8	Laboratory :
Identification of the sample :	Date :
	Operator :

Water content w	%
Mass M_1	g
Mass M_2	g
Mass M_3 (if used)	g
Fines content f	%

		1st test specimen	2nd test specimen
Mass of test specimen M_T	g		
h_1	mm		
h_2	mm		
100 (h_2/h_1) (recorded to 1 decimal place)			
NOTE Values of 100 (h_2/h_1) for the two test specimens should not differ by more than 4.			

Sand Equivalent value *SE(10)* – the average of 100 (h_2/h_1) for the two test specimens.

SE(10) = ____ (to nearest whole number)