Sampling and analysis of glass-making sands —

Part 1: Methods for sampling and physical testing of glass-making sands

ICS 81.040.10

British Standards

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee LBI/36, Laboratory glassware and related apparatus, upon which the following bodies were represented:

British Glass Manufacturers Confederation
CLEAPSS School Science Service
GAMBICA Association Ltd.
Institute of Biomedical Science
LGC Ltd.
Royal Society of Health
Society of Glass Technology

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 14 December 2004

First published March 1958
Second edition February 1988
Third edition December 2004

The following BSI references relate to the work on this British Standard:
Committee reference LBI/36
Draft for comment 04/30090021 DC

ISBN 0 580 44940 8

Amendments issued since publication

Amd. No.	Date	Comments

Contents

Foreword

This British Standard was prepared by Technical Committee LBI/36.
BS 2975-1:2004 together with Part 2 (when published) supersedes BS 2975:1988, which is now withdrawn.

This revision of BS 2975 is published in two parts, as follows:

— *Part 1: Methods for sampling and physical testing;*

— *Part 2: Methods for chemical analysis.*

This part updates the methods for sampling and the physical testing of glass-making sands described in Clause **2** and Clause **3** of BS 2975:1988. It incorporates appropriate requirements from complementary standards describing the sampling and physical testing of aggregates: BS EN 932-1:1996, BS EN 932-2:1999, BS EN 933-1:1997 and BS EN 1097-5:1999.

Annex A (informative) gives recommendations for particle size distribution, moisture content and typical end-uses of different glass-making sands, previously described in Annex B and Annex D of BS 2975:1988.

Part 1 updates the methods for sampling and physical analysis whilst Part 2 updates the methods for chemical analysis of glass-making sands described in Clause **4** of BS 2975:1988. Part 2 also includes recommendations for the chemical composition of glass-making sands and details of standard reference sands.

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

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, an inside back cover and a back cover.

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1 Scope

This British Standard describes a method of sampling and physical testing of sands used for a variety of glass-making activities with the intention of providing a basis for either continued supply of established materials or for evaluation of new sources of silica sand.

NOTE Annex A illustrates commonly encountered particle size distribution and moisture content of glass-making sands.

2 Normative references

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

BS 410-1:2000, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth* (ISO 3310-1:2000).

BS EN 932-1:1996, *Tests for general properties of aggregates — Part 1: Methods for sampling.*

BS EN 932-2:1999, *Tests for general properties of aggregates — Part 2: Methods for reducing laboratory samples.*

BS EN 933-1:1997, *Tests for geometrical properties of aggregates — Part 1: Determination of particle size distribution — Sieving method.*

BS EN ISO 3696:1995, *Water for analytical laboratory use — Specification and test methods.*

3 Sampling

3.1 Principle

Homogeneous sampling of granular materials is difficult due to segregation of particles caused by grain size differences and variations in specific gravity of trace mineral suites. Inappropriate sampling is probably the most important factor causing poor precision in test work results. Detailed descriptions of sampling processes are provided to allow consistency in sampling by operators of varying experience.

3.2 Apparatus

3.2.1 *Stout plastic sheeting*, for mixing surface for bulk samples.

3.2.2 *Glass jars with contamination free seals*, for retention of initial condition of sample.

3.2.3 *Strong polythene bags with seals*, for retention of condition of sample.

3.2.4 *Nickel or stainless steel spatulas*, for sample mixing and selection.

3.2.5 *Distilled or ion-exchanged laboratory water*, for adjustment of water content.

3.2.6 *Riffle boxes of steel or plastics*, for sample selection.

3.2.7 *Rotary sample divider (optional)*, for sample selection.

3.2.8 *Large porcelain or agate pestle and mortar*, for homogenization of initial sample.

3.2.9 *Laboratory oven to 110 (±5) °C*, for drying operations.

3.2.10 *Disposable non contaminating oven dishes*, for drying operations.

3.2.11 *200 mm diameter sieves of stainless steel or phosphor bronze conforming to BS 410-1:2000*, according to sand specification.

3.2.12 *Mechanical sieve shaker.*

3.2.13 *Sieve brushes.*

3.2.14 *Analytical balance*, to 0.01 g at 200 g loading.

3.2.15 *Analytical balance*, to 0.1 g at 10 kg loading.

3.2.16 *Hand magnet*, for ferro-magnetic particle separation.

3.2.17 *Ventilated exhaust hood (optional)*, for heavy liquid separation with high vapour pressure liquids.

3.2.18 *Water immiscible heavy liquids (optional)*, appropriate to density of mineral phase sought for heavy liquid separation (ventilated).

3.2.19 *Water miscible heavy liquids (optional)*, appropriate to density of mineral phase sought for heavy liquid separation (unventilated).

3.2.20 *Acetone (optional),* for heavy liquid removal from samples.

3.2.21 *Plastic funnels.*

3.2.22 *Borosilicate separating funnel.*

3.2.23 *Filter papers.*

3.2.24 *Polarizing stereoscopic microscope to (at least) 50 magnifications with facility for transmitted and reflected light*, for identification of trace mineral species and surface textures.

3.3 Bulk sample

Obtain a sample representative of the delivery as follows.

a) Take separate and approximately equal increments from at least 12 different places, including the top, centre and bottom of the delivery, to produce a sample with a total mass of at least 10 kg.

b) Immediately after taking the sample, mix the increments well and pack into a suitable container. Seal it in order to retain the sand in the “as received” condition until the sample is opened for test.

NOTE Glass jars, fitted with closures which will not contaminate the sand, or strong sealable polyethylene bags are suitable. Metal containers or closures should not be used.

c) In cases where:

1) non-friable coarse particles are present;

2) mineralogical examination is required (e.g. for refractory particles);

3) trial glass melts are to be conducted; or

4) where oversize particle analysis is required;

obtain a separate sample of at least 10 kg for each additional purpose.

In circumstances where adjustment of sample size of dry samples is required, follow the procedure given in BS EN 932-2:1999.

In circumstances where the sample is damp, follow the procedures given in BS EN 932-1:1996, **9.4**, **9.5** and **9.6**, quartering and fractional shovelling.

NOTE Where investigation is required for granular condition or detection of trace detrimental mineralogy (e.g. chromite, corundum, spinel), samples of up to 50 kg might be required.

3.4 Preparation of samples for moisture determination

Thoroughly mix the bulk sample (see **3.3**) in a suitable dish or other container or on a clean non-absorbent surface.

Take 10 separate increments, each of mass of approximately 10 g, and use the combined sample (mass approximately 100 g) for the determination of the moisture content (see **4.1**).

NOTE 1 A suitable surface is a sheet of glass or stout polyethylene sheet spread on a work bench or table.

NOTE 2 It is important to determine the moisture content as soon as possible after taking the initial sample to avoid losses of water by evaporation or absorption.

3.5 Preparation of the laboratory sample and samples for inspection, for the determination of particle size distribution, for refractory mineral examination or for trial glass melts

3.5.1 *General*

Thoroughly mix the material remaining after taking the sample for moisture determination (see **3.3**), wetting, if necessary, by spraying with water so that the sand can be moved freely without balling. Water produced by distillation, ion exchange or another suitable method complying with BS EN ISO 3696:1995 shall be used.

NOTE When dry sand is moved or handled, there will be some segregation of the different sizes of grain and of the contained minerals. Wetting the sand to between 1 % (m/m) and 5 % (m/m) water produces sufficient adhesion between the grains to minimize this segregation.

Spread the uniformly wetted sand on a non-absorbent surface and distribute it in a layer of uniform thickness. Use sample size reduction techniques described in BS EN 932-2:1999.

When test increments are required for subsequent test work and a riffle box or mechanical divider is available, dry the laboratory sample at 110 (±5) °C.

For sample size reduction methods that either:

a) specify only a lower limit to the test increment mass; or

b) allow a sizeable tolerance around a target mass

the following methods of subdivision may be used:

1) subdivision using a rotary sample divider;

2) subdivision using a riffle box;

3) subdivision using incremental shovelling;

4) subdivision by quartering.

NOTE Subdivision by rotary sample divider is the preferred procedure. Quartering is not recommended for wide gradings.

Further reduce the mass of the sample, as appropriate, to obtain this "laboratory sample" with a mass of approximately 1 kg.

For methods that specify a test increment mass within a small tolerance, tip the sub-sample on to the working surface, mix it thoroughly and form a line of sand across the working surface. Starting at one end of the line, and using a flat-bottomed scoop or a scraper, continue to withdraw sand from that end until a test increment of sufficient mass is obtained. Take care that smaller particles are not left behind.

3.5.2 *Preparation of sample for inspection*

Where the laboratory sample is dry, using a mechanical divider, subdivide the free-flowing laboratory sample with a rotary sample divider or riffle box of appropriate dimensions to obtain a sample of about 500 g.

Where the laboratory sample is damp, carry out subdivision using incremental shovelling or quartering to obtain a sample of about 500 g.

3.5.3 *Preparation of sample for particle size analysis*

Using a mechanical divider, subdivide the free-flowing (i.e. dry or dried) laboratory sample by rotary sample divider or riffle box of appropriate dimensions to obtain a sample of about 100 g or a smaller mass that has been demonstrated to be statistically representative for the purposes of chemical analysis of the particular material under test.

Where the laboratory sample is damp, carry out subdivision using incremental shovelling or quartering to obtain a sample of about 100 g.

3.5.4 *Preparation of sample for chemical analysis*

Prepare a sample of about 100 g for analysis according to the condition (dry or damp) of the laboratory sample.

If the laboratory sample is dry, use a rotary sample divider or riffle box of appropriate dimensions suitable to provide a mass of sample matching the grinding capacity of the milling equipment.

If the laboratory sample is damp, use incremental shovelling or quartering to provide a mass of sample matching the grinding capacity of the milling equipment.

NOTE If any clay nodules or aggregates are present in the sand, the whole of the laboratory sample remaining after the inspection and particle size determination samples have been taken should be dried at 110 (±5) °C. The dried sample should be transferred to a large mortar (made of porcelain or agate, not of steel) and the aggregates broken down by gently crushing with a pestle. The sample should be wetted, mixed and sampled as described in **3.3.4** for damp sand to produce a sample mass appropriate to the grinding capacity of the milling equipment.

4 Physical analysis

4.1 Determination of moisture content in a ventilated oven

Prepare a test increment (as specified in **3.4**) to provide a mass of approximately 100 g. Clean and dry sufficient tray(s) to contain the test increment during drying. Weigh and record the mass of the tray(s) (M_1) to the nearest 0.1 g.

Spread the test increment out on the tray(s) to a thin layer. Weigh the tray(s) containing the moist test increment to the nearest 0.1 g (M_2). Place the tray(s) in a well ventilated drying oven at 110 (±5) °C for an appropriate period, remove, cool in a desiccator and reweigh to give constant mass (M_3).

Use successive weighings to determine the constant mass of the dried test increment. At all stages of handling and preparation before the start of the test, protect the laboratory sample and subsequent test increment from loss or gain of water.

Determine the water content as the difference in mass between the wet and dry mass either as a percentage of the wet mass or dried mass of the of the test increment. Calculate the water content W_w or W_d (%) in accordance with the following equations (expressing the result to the nearest 0.1 %):

$$W_w = \frac{100(M_2 - M_3)}{(M_2 - M_1)} \qquad \text{(Wet mass calculation)}$$

$$W_d = \frac{100(M_2 - M_3)}{(M_3 - M_1)} \qquad \text{(Dry mass calculation)}$$

Depending on whether dry or wet mass calculation occurs, a small difference in obtained value will result. For example, if a 100 g sand sample contains 5 g of water and 95 g of sand, the wet mass calculation is

$$100 \times \frac{5}{5 + 95} \qquad W_w = 5\%$$

Whereas, the dry mass calculation is

$$100 \times \frac{5}{95} \qquad W_d = 5.3\%$$

NOTE 1 Constant mass is defined as successive weighings after drying at least one hour apart not differing by more than 0.1 %. In many cases, constant mass can be achieved after a test increment has been dried for a pre-determined time in a specified oven at 110 (±5) °C. Test laboratories can determine by experience the time required to achieve constant mass for specific types and sizes of sample dependent upon the drying capacity of the oven used.

NOTE 2 The container used should be large enough to store the test increment before testing. The container should be non-corrodible, closed and may not contaminate the sand. Suitable containers for use in the oven might be disposable aluminium foil dishes.

4.2 Determination of particle size distribution by sieve analysis

4.2.1 *Sieving*

Particle size distribution by sieve analysis shall be performed in accordance with BS EN 933-1:1997, except that test increment masses may be as small as deemed adequate, e.g. when overloading of one or more sieves would occur with a standard charge of 100 g.

Dry the whole of the 100 g sample obtained as described in **3.5.3** at 110 (±5) °C to constant mass. Allow to cool and weigh to the nearest 0.01 g. Transfer the sample to a nest of sieves complying with BS 410-1:2000, selected from Table 1. Fit the nest with a cover and receiving pan and sieve mechanically for at least 15 min. Separate the sieves and invert in turn (carefully without particle loss) onto a piece of clean glazed paper, and brush any particles lodged in the meshes onto the paper. Weigh each increment and that collected in the receiving pan to the nearest 0.01 g and calculate the percentage of the sample retained on each sieve. Report the results to ± 0.1 % (see Clause **5**).

To avoid overloading of sieves, the fraction retained at the end of the sieving operation on each sieve (expressed in grams) shall not exceed the masses given in Table 1.

The actual sieves chosen shall accord with the specification of the product.

To prevent overloading of a sieve, other sieves not required by the specification may be used as spacers.

Table 1 — Permitted sieve aperture sizes and maximum mass of sand retained on 200 mm diameter woven wire sieves on completion of sieving

Principal sizes (R 20/3 series)	**Supplementary sizes (R 40/3 series)**	**Theoretical maximum mass allowed at completion of sieving** g
1.000		119
0.710		102
	0.600	100
0.500		85
0.355		68
	0.300	65
0.250		60
0.180		51
	0.150	50
0.125		43
0.090		36
	0.075	30
0.063		29

NOTE 1 Maximum mass retained on completion of sieving is based on the volume recommended in BS 1796-1:1989 assuming an apparent bulk density of 1.7 Mg/m^3.

NOTE 2 Sieve aperture sizes (mm) derived from BS 410-1:2000.

NOTE 3 Allowance may need to be made for variation of bulk density across the sieve range used. Finer fractions exhibit lower bulk densities than coarser fractions (see Table 2).

Table 2 — Example variations in bulk density for sands of European origin

Size range µm	**Bulk density**
More than 1000	1.51
1 000 to 710	1.51
710 to 500	1.51
500 to 355	1.51
355 to 250	1.51
250 to 180	1.56
180 to 125	1.47
125 to 90	1.42
90 to 63	1.38
Less than 63	1.28

4.2.2 *Weighing and calculation*

Weigh the retained material for the sieve with the largest aperture and record its mass as R_1.

Carry out the same operation for the sieve immediately below and record the mass as R_2.

Continue the same operation for sieves in the stack and record the masses of the respective retained fractions as R_3, R_4, ...R_n where n is the total number of sieves in the stack. Record the residual mass present in the pan (passing the finest sieve) as P.

Calculate the mass retained on each sieve (R_x),where x represents any sieve in the stack, as a percentage of the original dry mass M_1.

Calculate the fines (P) separately, if required, as a percentage of the original test increment mass M_1.

NOTE Commonly, it will be necessary to transfer the sieve charge to a smaller container for weighing. In this case, observe precautions as noted in **4.2.3**. In other cases, particularly where automatic weight transfer to a laboratory PC is possible, direct weighing of the sieve and charge may be performed on a top pan balance of suitable accuracy equipped with a sufficiently large platen to accommodate the sieve.

4.2.3 *Brushing of particles from sieves into a collecting vessel for weighing*

Screen brushes are available with twin-ended bristles. One end has stiff bristles and the other softer bristles. Use the stiff bristle end for sieves of aperture greater than 150 µm and the soft end for sieves with nominal apertures finer than this. For screens of 150 µm and below, brush carefully from the reverse side of the sieve. Take great care not to allow the ferrule of the brush to come into contact with the sieve mesh material. This will cause damage to the sieve by distorting or tearing the mesh.

NOTE Any test increment used for grain size distribution may not be used for chemical analysis subsequently.

4.3 Determination of coarse particle content (retained on a 1.00 mm sieve)

Sieve a 10 kg sample on a sieve of nominal aperture 1.00 mm. Weigh the retained fraction or report the number of particles (see Clause **5**).

4.4 Qualitative inspection procedures for contamination particles

NOTE This subclause describes inspection procedures recommended for sands from new or uncertain sources. The procedures are not normally applied to sand from known and continuous supplies, unless it has been recognized that the sand supplier might have changed mineral processing techniques or might be experiencing difficulties with processing equipment. The importance of some aspects of these procedures might also become significant if the glassmaker changes refining and melting habits. For example, the nature of any trace mineralogy can assume more significance if melting and refining times are altered.

4.4.1 *Inspection for contamination*

Spread the inspection sample (see **3.5.2**) in a layer about five millimetres thick on a clean flat surface and examine it for the presence of impurities that are clearly contaminating the sand. Note the type, approximate quantity and, if possible, the identity of such particles (see **4.4.2**).

Obtain a smaller sample of approximately 50 g by incremental shovelling, dry at 110 (±5) °C. Spread the sample in a thin layer and extract any magnetic material by passing a magnet wrapped in a polythene sample bag, through the sample. Examine the ferromagnetic extract by microscope to differentiate between adventitious tramp iron or iron scale (from mineral processing, transport or batch house operations) and naturally occurring minerals such as magnetite. Include the results of this inspection in the test report (see Clause **5**).

4.4.2 *Examination for minerals other than quartz*

NOTE Two methods for dense mineral separation are provided – one in a ventilated hood or fume cupboard (**4.4.2.1**) and one on the open bench (**4.4.2.2**).

4.4.2.1 *Method for investigation of dense trace mineralogy and texture effects in glass sands using heavy, water-immiscible organic liquids having a high vapour pressure and requiring positive ventilation systems*

By appropriate means (as described in **3.5**), separate from the laboratory sample a dry weighed sample of about 50 g. Add about 350 ml of a clean, filtered heavy liquid such as bromoform (density 2.89 Mg/m^3 at 20 °C), tetrabromoethane (density 2.964 Mg/m^3 at 20 °C), di-iodomethane (density 3.325 Mg/m^3 at 20 °C) or other liquid suitable for the mineral phase density sought, to a 500 ml, borosilicate, separating funnel inside a ventilation hood.

NOTE Where the mineral-processing suite has included froth flotation with sulfonate reagents to remove iron bearing contaminants, residues of reagent on the surface of the grains can cause air entrainment or particle aggregation upon addition to the heavy liquid. In this case, wash the test increment several times with small aliquots of acetone and allow air-drying before use.

Using a clean plastic weighing dish or plastic funnel, add carefully the test increment to the funnel. Stopper the flask then slowly rotate the flask with a tilting action to ensure that all particles are in contact with the liquid. Remove the stopper and carefully stir the grains into the bulk of the liquid using a glass rod. Stand inside the ventilation area on a funnel support for at least 20 min and up to a maximum of one hour. Carefully separate the heavy phases from the base of the funnel and run into a small borosilicate beaker of about 150 ml capacity, restricting the amount of entrained liquid to a minimum. Add 30 ml acetone to the beaker, homogenize the liquids by rotation and decant through a fibreglass filter paper. Wash the grains at least three times with 10 ml aliquots of acetone, extract the filter paper and grains from the filter funnel and stand on another filter paper inside the ventilated area until the grains are dry. Ensure the particles are free flowing prior to attempting microscopic examination.

Decant the “light” fraction through another filter paper, wash with three, 25 ml aliquots of acetone, extract the paper and allow to air-dry; set aside the dry light fraction for possible microscopic examination.

NOTE Retain the acetone diluted heavy liquid for recovery at a later date.

4.4.2.2 *Method for investigation of dense trace mineralogy and texture effects in glass sands using water-miscible heavy liquids without recourse to positive ventilation*

Observe the preparation stages as described in **4.4.2.1** with the exception that the separating medium in this case shall be a liquid such as sodium heteropolytungstate (SPT) with an initial density of 2.82 Mg/m^3 at 25 °C.

NOTE Modify the density downwards as required by adding de-ionized or laboratory quality water. Modify the density upwards as required to a maximum of 3.3 Mg/m^3 by heating. Modifying the density downwards to below 2.75 Mg/m^3 will result in extensive contamination of the “dense” fraction by quartz particles.

Add the test increment carefully to the SPT, tilting and rotating the flask slowly to include all particles. Using a glass rod, carefully stir the bulk of the particles down into the liquid. Stopper the flask and stand for at least 20 min and up to a maximum of one hour on the laboratory work surface.

Separate the heavy mineral phases carefully from the base of the funnel and run into a small 150 ml borosilicate beaker through a filter paper. Wash the entrained grains several times with 10 ml aliquots of distilled water, remove the paper from the filter funnel and stand on another paper to air-dry. Ensure the particles are free flowing prior to attempting microscopic examination.

Drain the separating funnel through another filter paper to recover the “light” fraction. Wash the fraction with three 25 ml aliquots of de-ionized or laboratory quality water and set aside to air-dry.

4.4.2.3 *Examination by stereomicroscope*

Spread the heavy fraction grains on a flat glass plate or dish to single grain thickness with a suitable microscope brush and mount on the rotating stage of a polarizing stereoscopic microscope fitted with an appropriate stage micrometer. Arrange for suitable illumination by plane polarized transmitted light, reflected light at an adjustable oblique angle or by both methods where appropriate.

Systematically examine the grains for the presence of ilmenite, rutile, brookite, leucoxene, tourmaline, staurolite, zircon, andalusite, kyanite, sillimanite, apatite, garnet, pyroxenes, amphiboles, olivines, pyrite (and other sulfides), corundum, chromite, epidote, muscovite, biotite, sphene and spinel. If possible, give an indication of the grain size spread of each phase.

Examine the surfaces of the grains in both the “light” and “heavy” fractions for development of secondary oxide coating films paying attention to the development of oxides and oxyhydroxides such as goethite, haematite, gibbsite, boehmite and very fine developments of illite and smectite clays. In particular, carry out physical tests using a fine non-magnetic stainless steel needle on the “light” fraction to determine the degree of adherence of the films with a view to determining the likelihood of significant coat detachment during handling of the material in bulk.

Examine for internal mineralization of grains in the “light” fraction using transmitted polarized light paying attention to the presence of magnetite, haematite and rutile. Provide an indication of the grain size of the “inclusions”.

Examine the surface texture of the quartz grains in the "light" fraction under both transmitted and oblique reflected light with a view to determining an overall indication of the angularity and roundness of the grains and comment on the contribution to melting and refining performance.

NOTE Chemical contamination due to contact with various heavy liquids can cause subsequent anomalous values for some elements if the "light" fraction is used for chemical analysis. For example, samples separated with SPT have shown anomalous sodium values. Similarly, samples separated with di-iodomethane show iodine contamination. In the case of analysis of titanium by XRFS, correction for the presence of iodine line overlap is necessary to provide correct values for titanium at trace level. In circumstances where samples have been prepared for XRFS by fusing in alkali metal borates, small additions of alkali metal iodides or iodates may have been made to the melt for reasons connected to release of the borate bead from platinum casting dishes. Correction protocols for the iodine derived from these sources will also be adequate to compensate for the influence of iodine from the separation liquid. Analogous problems arise for the analysis of aluminium by XRFS when heavy liquids contain bromine and/or when alkali bromides are added to facilitate release of borate beads from platinum.

5 Test report

A test report shall be provided, and shall include the following:

a) the identifier of this British Standard, i.e. BS 2975:2004;

b) sample identification;

c) test results.

Annex A (informative)
Particle size distributions and moisture content

Table A.1 illustrates commonly encountered particle size distribution and moisture content of some varieties of glass-making sands.

Table A.1 — Commonly encountered particle size distributions and moisture content of glass-making sands

Typical application	Optical glass	Tableware lead crystal	Boro-silicate	Colourless container	Clear flat glass	Coloured container	Insulating fibre
Moisture % mass	5.0 (±0.5)	4.5 (±0.5)	4.5 (±0.5)	4.5 (±0.5)	5.0 (±0.5)	4.5 (±0.5)	0.1 max
Retained on 1 mm sieve		Nil	Nil	Nil	Nil	Nil	
Retained on 710 µm sieve		0.25 max	0.25 max	0.25 max	0.25 max	0.25 max	
Cumulative retained on 500 µm sieve		5.0 max.	5.0 max.	5.0 max.	5.0 max.	5.0 max.	Nil
Retained on 355 µm sieve	Nil						
Retained on 250 µm sieve	15 max.						20 max.
Passing 125 µm sieve	5 max.	5 max.	13 max.	5 max.	5 max.	5 max.	
Passing 90 µm sieve		Nil	Nil	Nil	Nil	Nil	

Bibliography

BS 1796-1:1989, *Test sieving — Part 1: Methods using test sieves of woven wire cloth and perforated metal plate.* (ISO 2591-1:1998).

BS 2975:1988, *Methods for sampling and analysis of glass-making sands.*

BS EN 1097-5:1999, *Tests for mechanical and physical properties of aggregates — Part 5: Determination of the water content by drying in a ventilated oven.*

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