

Methods of testing mortars, screeds and plasters

Part 1. Physical testing

ICS 91.100.10

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee B/519, Masonry and associated testing, upon which the following bodies were represented:

- Autoclaved Aerated Concrete Products Association
- Brick Development Association
- British Ceramic Research Ltd.
- British Precast Concrete Federation Ltd.
- Building Employers' Confederation
- Concrete Block Association
- Department of the Environment (Building Research Establishment)
- District Surveyors' Association
- Local Authority Organizations
- Mortar Producers Association Limited
- National House (Building Council)
- Royal Institute of British Architects

The following bodies were also represented in the drafting of the standard, through a subcommittee:

- British Aggregate Construction Materials Industries
- British Cement Association
- British Civil Engineering Test Equipment Manufacturers' Association
- British Lime Association
- British Vermiculite Association
- Cement Admixtures Association
- Cementitious Slag Makers' Association
- Electricity Association
- Institute of Concrete Technology
- Quality Ash Association

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Foreword

This British Standard has been prepared under the direction of Technical Committee B/519, and is a new edition comprising section **1** and section **3** of BS 4551 : 1980. The main purpose of this new edition is to accommodate the changes brought about by the separating out of chemical methods of test to form BS 4551 : Part 2 and to introduce a small technical amendment to subclauses **10.2.1** and **10.2.3** of the 1980 edition. BS 4551 : Part 1 : 1998, together with Part 2 : 1998, supersedes BS 4551 : 1980, which is withdrawn.

This edition introduces technical changes, but it does not reflect a full review or revision of the standard which will be undertaken in due course, and which is likely to implement a new European Standard currently under development.

Compliance with a British Standard does not 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 26, an inside back cover and a back cover.



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Method

1 Scope

This Part of BS 4551 specifies methods of sampling, preparation and physical testing of mortars for bricklaying, screeding, plastering and rendering. The methods given in this standard are not intended to be applied to mortars containing high alumina cement.

2 References

2.1 Normative references

This Part of BS 4551 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this Part of BS 4551 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This Part of BS 4551 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this Part of BS 4551, the definitions given in Sections 6.1, 6.2, 6.3 and Subsection 6.6.2 of Part 6 of BS 6100 apply.

4 Sampling

4.1 Principle

This clause deals with the sampling of mortars and their subsequent reduction on site to a quantity suitable for despatch to a laboratory. It also includes directions for packaging and labelling of the samples.

4.2 Freshly mixed mortars

4.2.1 General

Samples shall be obtained by taking uniformly distributed increments. The samples shall be immediately combined and mixed thoroughly to form a representative combined bulk or sub-sample. The bulk or sub-sample shall be reduced in accordance with 4.2.4.

NOTE 1. It is preferable that samples are obtained from material in motion, provided this can be carried out in safety.

NOTE 2. The number of increments and the size of the bulk or sub-sample necessary depends on the quantity of the material and its variability, and the accuracy required of the test results.

4.2.2 Apparatus

4.2.2.1 Receptacle or scoop, metal, and of not less than 1 l capacity.

4.2.2.2 Airtight containers. The containers shall be clean and dry at the commencement of the sampling operation.

4.2.3 Taking of samples

4.2.3.1 Batch mixers

Sample the mortar at the discharge point of a batch from the mixer. Take not less than 12 increments spaced evenly through the batch. Take the increments by passing the receptacle across the stream of mortar in such a manner as to collect a thoroughly representative sample of mortar.

4.2.3.2 Conveyors, pumps, etc.

Where possible, take increments at the discharge of a conveyor or pipeline. Pass the receptacle across the stream of material, if possible so as to catch the whole of the stream, until it is filled. If it is not possible to catch the whole stream at once, pass the receptacle through the stream at a uniform rate in a manner that is varied on a systematic pattern for successive increments.

Where it is not possible to sample at the discharge point of the conveyor, take increments using a scoop from the full width and thickness of the stream of material on the conveyor after stopping the conveyor. The scoop used shall sweep the surface of the conveyor.

Take not less than 12 increments at regularly spaced intervals during the passage of the whole of the quantity of the material that is being sampled. Combine the increments to form one bulk sample.

4.2.3.3 Large hoppers, bins or heaps

Sample the mortar in accordance with 4.2.3.2 only when hoppers, etc., are being filled, prepared, emptied or removed.

4.2.3.4 Small hoppers, bins or heaps

Sample the mortar by means of the scoop at regular spacings throughout the mass. Take increments from material well below the surface in at least 12 different places in the mass, distributed in a regular manner so as to ensure, when mixed, a thoroughly representative combined sub-sample.

4.2.3.5 Bulk transport vehicles

Either sample the contents of bulk transport containers during filling or emptying by the procedures given in 4.2.3.2 or, when this is not practicable, by taking sub-samples as described in 4.2.3.4.

4.2.4 Reduction of sample

Reduce the bulk sample or sub-sample(s) to a mass of not less than 15 kg by taking sufficient scoopfuls from random positions throughout the mixed material. The reduced sample shall be placed in one or more airtight containers.

NOTE. If the consistence and air content tests are to be made on a sample, arrangements should be made to carry out the tests at the point of sampling.

4.2.5 Packaging and certificate of sampling

Each sample to be despatched to a laboratory shall be placed in one or more airtight containers, and suitably labelled so that its origin can be identified at the laboratory. The sample shall be accompanied by a certificate from the person responsible for taking the sample stating that sampling was carried out in accordance with the requirements of this British Standard.

The certificate shall include as much of the following information as is appropriate:

- a) type of material;
- b) the date, time, place and method of sampling;
- c) the quantity of the batch and consignment, or the period of production represented by the sample;
- d) tests required.

4.3 Hardened mortars

4.3.1 General

Because of the variety of circumstances in which sampling of hardened mortars may be required, only general guidance is given here. Samples may be required to ascertain the following:

- a) the variability in different parts of the work.
For this purpose, sub-samples should be kept separate and the areas represented by each should be carefully recorded. Results of tests on such samples should be regarded only as representative of the mortar from the area indicated;
- b) the composition at specific points, e.g. where defects have been observed.

In this case, the location and the depths from the surface of the work represented by the sample should be recorded;

c) the average composition over a significant area of masonry, plastering, rendering, or screed.

For this purpose, it should be realized that a number of different batches may have been used, and a number of sub-samples of approximately equal mass should be taken from representative areas and combined to make a composite main sample, which is as representative of the average as is practicable. The uncertainties in doing this inevitably limit the value of such average samples and these should be recognized when interpreting results. Care should be taken to avoid taking samples for this purpose predominantly from points at which the mortar is more readily extractable since the mortar at such points is likely to be untypical of the average composition;

d) information about adhesion.

In this case the sample should include the substrate.

4.3.2 Apparatus

4.3.2.1 Tools for cutting out the sample, such as hammer and bolster or cold chisel, or masonry or core drill.

4.3.2.2 Means of collecting representative samples, without loss of fine material.

4.3.2.3 Containers, that will prevent sample loss or contamination.

4.3.3 Size of samples

Samples for despatch to the laboratory shall each be not less than 100 g in mass. Where a number of sub-samples are combined to form one composite main sample, about the same amount of each sub-sample shall be included.

Where samples are intended to represent averages of the mortar over substantial areas of work, sub-samples shall be combined to form a composite main sample. The minimum size of sub-sample for each 10 m² and the maximum area represented by each composite main sample shall be as given in table 1.

Table 1. Representative sample sizes		
	Minimum mass of sub-sample to represent 10 m ² g	Maximum area represented by each composite main sample m ²
Brick or block work	50	50
Plastering or rendering	50	50
Floor screed	100	100

4.3.4 Taking of samples and source

4.3.4.1 Masonry mortar

Take a number of sub-samples sufficient to produce a representative quantity of mortar by removing a number of bricks or blocks from the construction. For most purposes, carefully remove the mortar from the bricks or blocks, avoiding contamination with the material of which they are composed. Take each sub-sample over the thickness of the structure of which it is intended to be representative, and record that thickness.

Where it is essential to avoid the removal of bricks or blocks, take the sub-samples using a masonry drill or core drill, or by chipping away the mortar. Ensure that the sub-samples are not contaminated with the material of which the bricks or blocks are composed, and that there is no loss of the finer material.

4.3.4.2 Plastering and rendering mortar

Take sub-samples from regularly spaced positions over the area to be examined. Where adhesion is good, cut out cores and, for most purposes, remove any adhering background material. Examine the background and record any observations.

NOTE 1. When a failure of adhesion to the background has occurred, appropriate areas may be removed with any convenient tool.

NOTE 2. When adhesion has failed between coats of mortar, separate sub-samples of each coat should be taken.

4.3.4.3 Screeding mortar

Each sub-sample shall be a coherent piece of full depth. Take the sub-samples from regularly spaced positions over the area to be examined. When a failure of adhesion to the sub-base has occurred break out appropriate sub-samples, using a hammer and cold chisel or bolster. Where adhesion is good, cut out or core the sub-samples. Examine the surface of the sub-base for the presence of grout and/or foreign matter.

4.3.5 Packaging and certificate of sampling

Each sample to be despatched to a laboratory shall be placed in one or more containers and suitably labelled so that its origin can be identified at the laboratory. The samples shall be accompanied by a certificate from the person responsible for taking the sample stating that sampling was carried out in accordance with the requirements of this British Standard.

The certificate shall include as much of the following information as appropriate.

- a) the date, time, place, and method of sampling;
- b) the location in the building of the area sampled, and the depths from the face of the structure represented by the sample;
- c) the state of the mortar at the time of sampling, e.g. wet or dry, soft or hard;
- d) such information as is available on the nature of the contiguous material, e.g. the type of brick or block, and any adhering material such as finishing plaster, paint, grout;
- e) reason for investigation and specified mix, if known.

5 Laboratory preparation of mortar mixes

5.1 Principle

This clause deals with the procedure to be followed when mortar is to be made from stated materials by mixing under laboratory conditions. General laboratory mixes should be made to the mass proportions specified in 5.2.7. There may, however, be a need for these mix proportions to be modified on the specific occasion when a change of proportions is required in order to obtain certain specified mortar properties.

NOTE. Table 2 may be used as a guide to the quantities of mortar required for the various tests.

5.2 Materials and proportioning

5.2.1 Fine aggregate (sand)

Any sample of fine aggregate (sand) to be used in mortar tests shall be thoroughly mixed before portions are withdrawn for use. Portions for test shall be taken either by using a suitable sample divider or by taking increments at random from the bulk as described in BS 812. All masses are based on dry fine aggregate (sand), and appropriate adjustments shall be made if damp fine aggregate (sand) is used.

Where standard fine aggregate (sand) is to be used it shall conform to BS 4550 : Part 5, but with the proportions of the various fractions in the mortar as given in table 3 of this standard.

Table 2. Guide to minimum quantity of material required for various tests

Clause number	Test	Volume of mortar to fill mould ml	Number of tests required ¹⁾	Total volume of mortar ml	Mass of fine aggregate (sand) ²⁾ g	Remarks
7	Consistence, by dropping ball	200	3	600	1020	Mortar may be used for other tests
8	Consistence retentivity and water retentivity	200	2	400	680	Mortar is discarded, but this test may be combined with that in clause 7
9	Flow	290	2	580	990	Mortar is discarded
10.2	Air content, by density method	500	1	500	850	Mortar may be used for the other tests
10.3	Air content, by pressure method	500	2	1000	1700	Mortar is discarded, but this test may be combined with that in 10.2
11	Stiffening rate	550	2	1100	1870	Mortar not available for other tests
12	Strength					Mortar not available for other tests
	25 mm × 25 mm × 160 mm prisms	63	6	380	640	
	40 mm × 40 mm × 160 mm prisms	255	6	1530	2600	
	70 mm cubes	355	6	2130	3620	
	100 mm cubes	1000	6	6000	10200	

NOTE. No allowance has been made for wastage.

¹⁾ The number of tests required gives the specimens for moulding to give the minimum number of test results.²⁾ Where the mortar is to be made solely for testing, this column applies. The mass of fine aggregate (sand) required for each test is calculated from the total volume of mortar by multiplying this by 1.7, an assumed relative bulk density for the fine aggregate (sand). No allowance therefore has been made for any increase in volume resulting from air entrainment or other causes.**Table 3. Percentages of fractions of standard fine aggregate (sand)s**

Fraction	A	B	C	D	E
Size	2.36 mm to 1.18 mm	1.18 mm to 600 µm	600 µm to 300 µm	300 µm to 150 µm	150 µm to 90 µm
Percentage	20	20	25	20	15

5.2.2 Cement

Any sample of cement shall be tested in accordance with the requirements of the appropriate standard, i.e. BS 12, BS 4027 or BS 5224, and shall conform to the stated limits.

5.2.3 Lime

Any sample of hydrated lime shall be tested in accordance with the requirements of BS 890. The available lime content of the sample, and also the free water content of lime putties, shall be determined using a (1 ± 0.01) g sample according to the methods given in **8.2.3** and **8.2.2** of BS 4551 : Part 2 : 1998.

5.2.4 Gypsum

All samples of gypsum plaster shall be thoroughly mixed to render homogeneous before portions are withdrawn for use. The sulfate content shall be determined by the method given in BS 1191. Report as $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$.

5.2.5 Ready-mixed lime: fine aggregate (sand) for mortar

Any sample of ready-mixed lime: fine aggregate (sand) for mortar shall be tested in accordance with the requirements of this standard and conform to the stated limits (see **10.2** of BS 4551 : Part 2 : 1998).

5.2.6 Air-entraining agent

Any sample of air-entraining agent shall be tested in accordance with the requirements of BS 4887 : Part 1 and shall conform to the stated limits.

5.2.7 Batch proportioning of mixes

All batching shall be by mass. Table 4 gives ranges of composition for mixes using fine aggregate (sand)s with a range of gradings.

For laboratory prepared mixes, except where particular properties of the mortar are specified, the proportions by mass shall be used as given in table 4.

NOTE. Although the properties of these mixes may differ slightly from those prepared using proportions based on actual bulk density values, this procedure is adopted in the interests of standardization.

Table 4. Composition of laboratory mixes						
Cement : fine aggregate (sand) screeds						
Screed designation	Percentage by mass on dry mass screeds %				Traditional volume proportioning	
a	Portland cement				cement : fine aggregate (sand)	
b	22.8				1 : 3	
c	18.0				1 : 4	
	14.0				1 : 5	
Cement-based mortars and plasters						
Mortar designation	Percentage by mass on dry mass of mix %					
	cement :	fine aggregate (sand)	cement :	lime :	fine aggregate (sand)	masonry cement : fine aggregate (sand)
i	22.8	77.2	22.9	1.5	75.6	—
ii	20.5	79.5	17.0	3.1	79.9	22.3
iii	14.0	86.0	13.6	5.1	81.3	15.8
iv	10.5	89.5	9.0	6.4	84.6	12.8
v	9.8	90.2	7.1	8.0	84.9	11.0
Gypsum : lime : fine aggregate (sand) plasters						
Traditional volume proportioning			Percentage by mass on dry mass of mix %			
gypsum :	lime :	fine aggregate (sand)	gypsum (as CaSO ₄ . ½H ₂ O)	lime (Ca(OH) ₂)	fine aggregate (sand)	
1	0	1.5	18.0	—	82.0	
3	2	6	13.5	8.5	78.0	
1	1	3	9.5	9.0	81.5	
1	3	9	3.5	10.0	86.5	

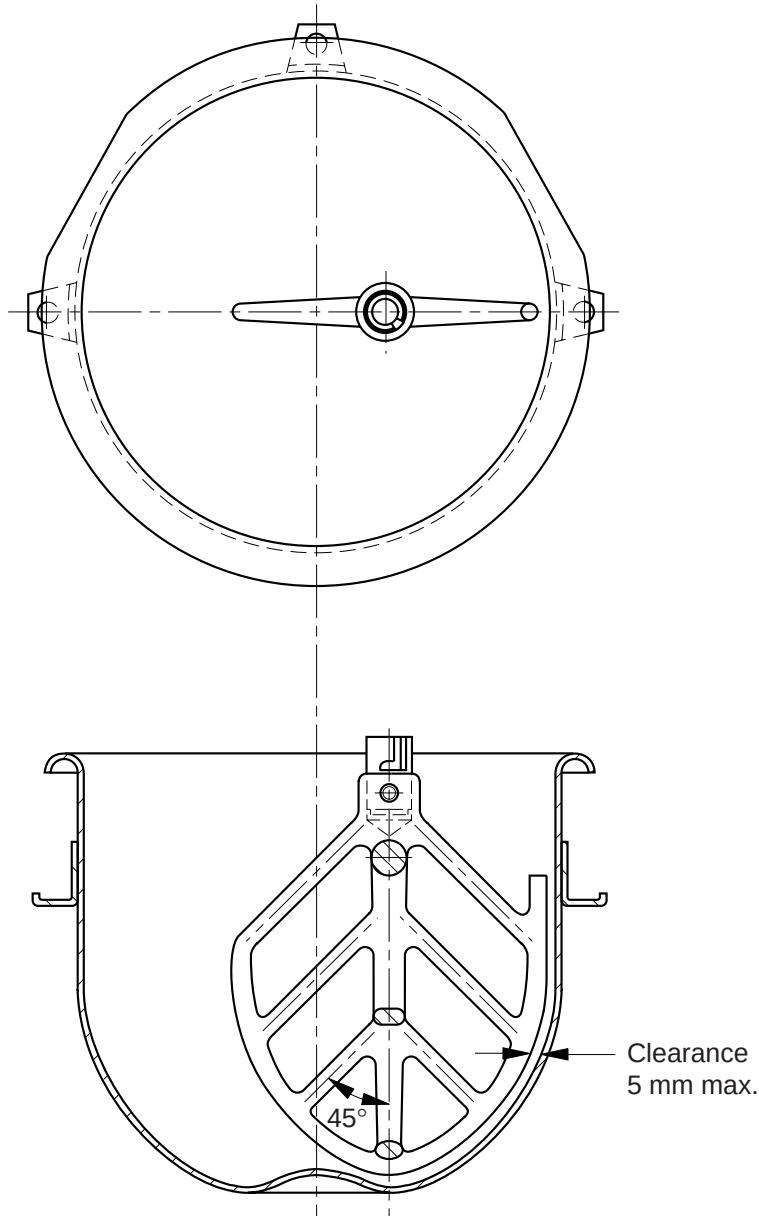


Figure 1. Typical mixer bowl and blade

5.3 Mixing apparatus

5.3.1 Mixer, with a blade rotating axially at (120 ± 25) r/min and in a planetary motion at (60 ± 15) r/min, with a bowl and blade of the general form shown in figure 1, and a capacity of between 5 l and 20 l according to the amount of mortar required by the testing laboratory.

5.4 Mixing procedures

5.4.1 When solid ingredients are to be mixed with liquids

Bring all the materials to a temperature of $(20 \pm 2) ^\circ\text{C}$ before commencing the mixing of the mortar. Carry out the mixing in a room temperature of $(20 \pm 5) ^\circ\text{C}$ but preferably within closer limits.

Place all the solid materials in the mixing bowl of the appropriate size and mix for 30 s.

NOTE. When a powdered admixture is used, and if this has not been dissolved in the mixing water, it will be necessary to premix it with one of the dry materials for several minutes to ensure adequate dispersion.