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Masonry —

Part 4: Test methods

Maçonneries —

Partie 4: Méthodes d'essai

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 9652 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 9652-4 was prepared by Technical Committee ISO/TC 179, *Masonry*, Subcommittee SC 3, *Test methods*.

ISO 9652 consists of the following parts, under the general title *Masonry*:

— *Part 1: Unreinforced masonry design by calculation*

— *Part 2: Unreinforced masonry design by simple rules*

— *Part 3: Code of practice for design of reinforced masonry*

— *Part 4: Test methods*

— *Part 5: Vocabulary*

Annex A forms a normative part of this part of ISO 9652.

Introduction

ISO/TC 179 is responsible for the International Standards for design of masonry, either by calculation (see ISO 9652-1) or by simple rules (see ISO 9652-2). The test methods given in this part of ISO 9652 are standard reference test methods. They are used to determine the properties of masonry units, mortars and masonry elements needed in the design of structures.

Test methods in national standards for determining the resistance of masonry units and elements to loads show considerable differences. This no doubt reflects both the history of the derivation of the test and the purpose to which the results are put, but the effect is that design methods are different in different countries. Researchers into masonry problems may use test methods, which differ again.

National standards are appropriate for use in a particular country, as are research methods for specific investigations. However, parallel tests following the methods given in this part of ISO 9652 are necessary in order to establish a relationship between them and in order that a precise comparison of test results using different test methods may be obtained with confidence.

The results from the reference test methods in this part of ISO 9652 are intended to provide a basic common datum against which data obtained by different test methods may be strictly compared. More attention has been paid to precision and repeatability than to the provision of test methods of universal applicability.

Even if all laboratories do not have the equipment to carry out these standard reference tests, there will usually be a national, often governmental, laboratory that has.

Masonry —

Part 4: Test methods

1 Scope

This part of ISO 9652 specifies reference methods for testing

a) the compressive strength of masonry units;

b) the compressive strength of masonry;

c) the flexural strength of masonry;

d) the water absorption of clay units; and

e) the compressive strength of mortar.

It is applicable to masonry built with units of fired clay, calcium silicate, concrete (including autoclaved aerated concrete), natural stone or manufactured stone.

NOTE The methods may be suitable for testing other walling materials, but they have not been examined as reference tests in this respect.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 9652. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 9652 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters.*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method.*

ISO 9652-5, *Masonry — Vocabulary*.

3 Terms and definitions

For the purposes of this part of ISO 9652, the terms and definitions given in ISO 9652-5 apply.

4 Sampling

The method of sampling and the number of specimens shall be stated in the test report and shall be chosen so that the sample is representative of the batch to be tested. If the testing laboratory does not carry out the sampling, this shall be stated in the test report.

5 Determination of compressive strength of masonry units

5.1 General

The load at which a masonry unit fails in a compression test machine divided by the loaded area is defined as the crushing strength of that single unit. The compressive strength is defined as the arithmetical mean of the crushing strengths of a sample. The standard reference test requires a sample of 10 specimens, but provision is made for a smaller sample of 6 to be used when the coefficient of variation is known to be low. It is the best guide to the strength of the consignment from which the sample was taken and may be used in conjunction with information about the composition of the mortar used in construction to estimate the strength of the resulting masonry wall.

The test procedure uses a standard method of preparation to ensure that the surfaces are essentially plane and parallel so that the load is evenly distributed over the tested area. Specimens are tested wet but factors are provided to enable the results to be modified to give an approximate value for an air-dried specimen and to transform the result by means of a shape factor correction to bring different sized units to assumed equivalence.

In the test report there is provision for "Remarks" under which exceptional features (e.g. badly cracked, chipped or misshapen specimens) should be recorded.

5.2 Sample size

Sampling shall be carried out in accordance with clause 4. The number of specimens shall be at least 10. If the coefficient of variation is known to be not greater than 15 %, the number of specimens may be reduced to 6.

5.3 Preparation of specimens

5.3.1 Test specimens

Use test specimens sampled in accordance with clause 4. Concrete masonry units other than autoclaved ones shall be stored for the required number of days before testing. This shall be recorded in the test report (see 5.7).

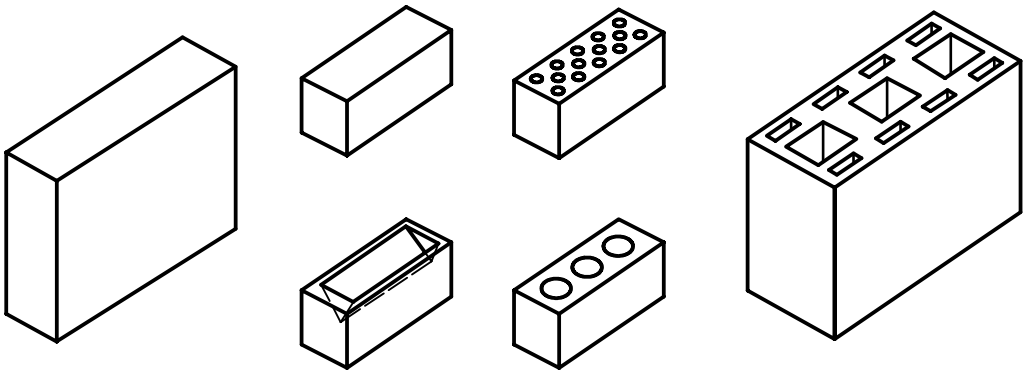
For certain forms of construction, it will be necessary to test the units in more than one orientation.

Units used in the normal manner are understood to be laid with their bed faces horizontal, as shown in Figure 1.

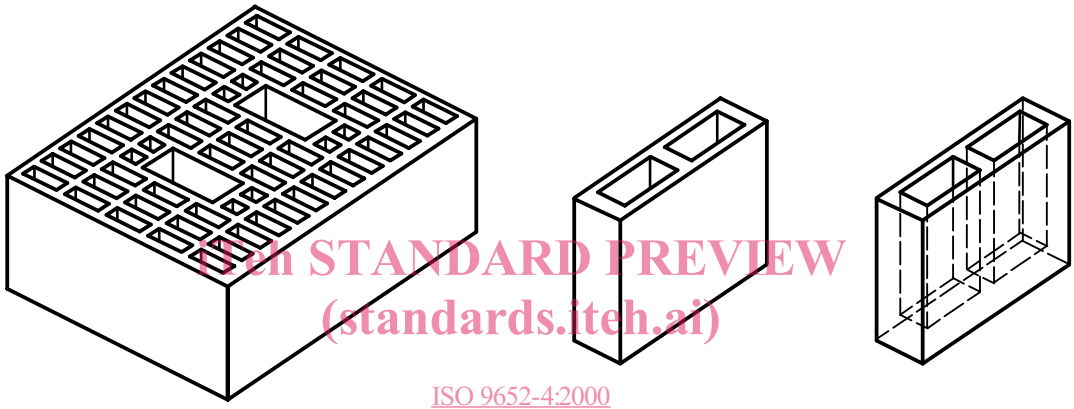
5.3.2 Dimensions of units

5.3.2.1 General

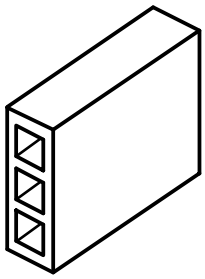
In order to meet the requirements of d) and e) of the test report (see 5.7), make a sketch and description of the unit using the following procedures (see Figure 2).



a) Group I Units which are solid or with ⩽ 25 % by volume of formed vertical holes that may or may not pass right through the unit, or units with ⩽ 25 % by volume of frogs in the bed faces

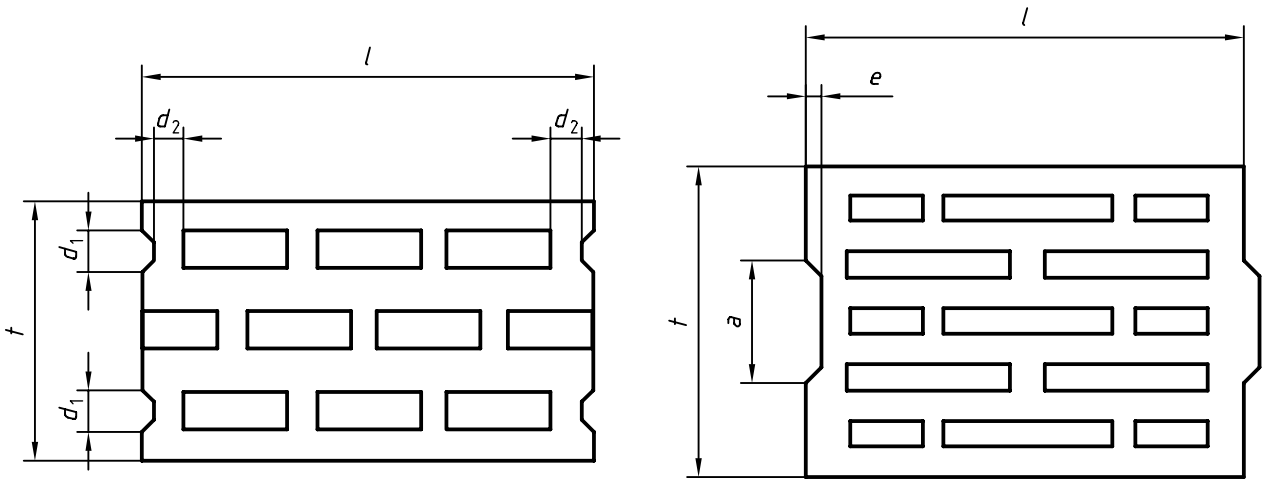


b) Group II Units with > 25 % and < 60 % by volume of formed vertical holes which may or may not pass through the units



c) Group III Units with < 50 % by volume of formed horizontal holes, which may or may not pass through the units

Figure 1 — Units in normal aspect



l = length

t = width

Figure 2 — Example of dimensions

5.3.2.2 Gross area of the loaded surface

This subclause applies to all types of masonry unit, including those to be used with a divided joint (face-shell bedded), that is, the gap between the twin strips of mortar is included in the overall area (see 5.5.1).

Make three measurements of the dimensions of the gross plan area to the nearest 1 mm at the top, middle and bottom of the unit. Multiply the means of these three measurements of length and width together to calculate the gross area.

5.3.2.3 Determination of the proportion and size of voids

Measure the dimensions of the voids directly if they are large enough. Calculate and record the total cross-sectional area of voids and express it as a percentage of the gross area. Otherwise proceed as follows.

a) Make three measurements of the height of the unit to the nearest 1 mm at the middle and two ends. Use the mean to multiply by the gross area to obtain the gross volume that is recorded to the nearest 1 000 mm^3.

b) Place the unit on a thin sheet of foam rubber with the holes in a vertical position. Using a measuring cylinder filled with fine dry sand, fill the holes and record the volume of sand used, to the nearest 1 000 mm^3.

c) Express the volume of sand as a percentage of the gross unit volume.

5.3.2.4 Net area

If the voids were measured directly, subtract the cross-sectional area of voids from the gross area to obtain the net area. To find the average net area of units with voids too small to be measured directly, subtract the volume of the voids from the gross volume and divide by the mean height.

5.3.3 Bed face preparation

5.3.3.1 General

Prepare each specimen so that the bed faces are plane to a tolerance of 0,1 mm per 100 mm of gauge length and the top surface lies between two parallel planes not greater than 1 mm apart in 500 mm and parallel to the bottom surface. If the unit already meets these requirements, then test it directly. Otherwise use grinding or, as an alternative, capping with mortar as described in 5.3.3.2. Fill frogs and allow the mortar to cure before grinding.

5.3.3.2 Capping procedure

5.3.3.2.1 General

Immerse the specimens in water for 18 h and then allow them to drain for approximately 10 min. Wipe off the surplus water.

Use a capping mortar consisting of one part by volume of clean, well-graded sand with a maximum grain size of 2 mm, mixed with one part by volume of cement. The compressive strength of the mortar at the time of the test, determined as described in clause 6, shall be not less than 30 N/mm^2.

Treat each of the two bed faces in turn as described below, using mortar of the same composition made with the same constituents

5.3.3.2.2 Units without holes or with holes unfilled

NOTE Ground plate glass or machined steel plates are the most suitable materials. The flatness tolerance can be checked by measuring deviations from straightness along a line parallel to, and close to, each specimen edge; along each diagonal and along each centreline, using a straight edge raised by pads of equal thickness at each end of the specimen and an appropriate gauge at the centre. The deviation from flatness may be obtained be relating the deviations from straightness at the centre point of the plate and at other points where the lines described intersect.

5.3.3.2.2.1 Bed each specimen in the mortar on a smooth rigid plate, at least 25 mm longer and wider than the specimen, and plane to within 0,05 mm, using the following procedure.

a) Support the plate firmly with the machined face uppermost and level it in two directions at right angles, using a spirit level. Coat the plate with a film of mould-release oil or a sheet of thin paper to prevent mortar adhering.

b) Spread a uniform layer of mortar about 5 mm thick on the plate. Press one bed face of the specimen firmly into it. Check that the vertical axis of the specimen is perpendicular to the plane of the plate using a square or vertical level to check each vertical face. When bedding hollow blocks, it will be found an advantage to shape the mortar layer so that it is a little thicker in the middle than at the edges so that air is not trapped under the block when it is pressed into the mortar.

c) Ensure the mortar bed is at least 3 mm thick over the whole area and that any cavity normally filled when the units are laid in the wall is completely filled with mortar. Do not fill other cavities.

d) Trim off surplus mortar flush with the sides of the specimen. Cover it with a cloth, kept damp. Allow the bedded specimen to remain undisturbed for at least 16 h and then carefully remove it from the plate without damaging the mortar.

e) Examine the mortar bed for defects such as lack of compaction, cracking and lack of adhesion to the specimen. Replace such defective specimens.

5.3.3.2.2.2 Bed the second bed face using the same process.

5.3.3.2.3 Units with frogs intended to be filled

Treat each of the two bed faces in turn as described below.

a) Fill the frog with capping mortar and strike off level.

b) At the time that the top frog is filled, bed the base of the unit in a similar mortar mix as described in 5.3.3.2.1. For bricks with two frogs, fill the lower frog before inverting the brick onto the mortar bed. Store under damp sacking, polyethylene or similar material until the mortar has hardened.

5.3.3.2.4 Units to be face-shell bedded

5.3.3.2.4.1 Bed each specimen in the mortar on a smooth rigid plate (see Note in 5.3.3.2.4.2) at least 25 mm longer and wider than the specimen, and plane to within 0,05 mm, using the following procedure.

a) Support and coat the plate as described in 5.3.3.2.2.

b) Lay two parallel strips of mortar about 5 mm thick on the plate such that each strip is about 25 mm longer than the length of the unit and about 10 mm wider than the face shell.

c) Press one bed face of the unit into the mortar such that the thickness of the mortar over the face-shells is at least 3 mm. Check that the vertical axis of the specimen is perpendicular to the plane of the plate using a square or vertical level to check each vertical face.

d) Trim off any surplus mortar and store the specimen in accordance with 5.3.3.2.2.

e) Examine in accordance with 5.3.3.2.2.

5.3.3.2.4.2 Bed the second face using the same process.

NOTE The distance between the strips should be approximately equal to the distances between the face-shells less 10 mm.

5.3.3.3 Storage of specimens

After the second capping layer has hardened sufficiently (3 to 7 days), immerse the specimens in water or cure them under sacks kept damp throughout the curing period or in a conditioning chamber at greater than 90 % relative humidity.

5.3.4 Conditioning of specimens before testing

Immerse the specimens in water for at least 24 h. Remove and allow to drain without drying out before testing (normally about 15 min).

5.4 Apparatus

Test the specimens in an appropriate machine regularly calibrated to ensure that it complies with the requirements given in Table 1.

Table 1 — Requirements for testing machines (for masonry units)

Maximum permissible repeatability of forces as a percentage of indicated force	Maximum permissible mean error of forces as a percentage of indicated force	Maximum permissible error of zero force as percentage of maximum force of range
1,0	± 1,0	± 0,2

The testing machine shall have adequate capacity to crush all the test specimens, but the scale used shall be such that the ultimate load on the specimen exceeds one-fifth of the full-scale reading.

The machine shall be provided with a load pacer or equivalent means to enable the load to be applied at the rate given in 5.5.2.