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ICS

Masonry units — Methods of test

Part 1:

Determination of compressive strength

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ICS

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Coast Clay Works Ltd.

Consumer Information Network

University of Nairobi

Kenya Industrial Research & Development Institute

Architectural Association of Kenya

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Foreword

ICS

This Kenya Standard was prepared by the Clay and Clay Products Technical Committee under the guidance of the Standards Projects Committee and in accordance with the procedures of the Kenya Bureau of Standards.

During the development of this standard, reference was made to the following document:

BS EN 772-1:2011+A1:2015 Methods of test for masonry units - Part 1: Determination of Determination of compressive strength.

Acknowledgement is hereby made for the assistance received from this source.

Masonry units — Methods of test

Part 1:

Determination of compressive strength

1 Scope

This Kenya Standard specifies a method for determining the compressive strength of masonry units.

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 771-1, Specification for masonry units — Part 1: Clay masonry units

EN 771-2, Specification for masonry units — Part 2: Calcium silicate masonry units

EN 771-3, Specification for masonry units — Part 3: Aggregate concrete masonry units (Dense and lightweight aggregates)

EN 771-4, Specification for masonry units — Part 4: Autoclaved aerated concrete masonry units

EN 771-5, Specification for masonry units — Part 5: Manufactured stone masonry units

EN 771-6, Specification for masonry units — Part 6: Natural stone masonry units

EN 772-2, Methods of test for masonry units — Part 2: Determination of percentage area of voids in aggregate concrete masonry units (by paper indentation)

EN 772-10, Methods of test for masonry units — Part 10: Determination of moisture content of calcium silicate and autoclaved aerated concrete units

DKS 2802-7, Methods of test for masonry units — Part 13: Determination of net and gross dry density of masonry units (except for natural stone)

DKS 2802-8, Methods of test for masonry units — Part 16: Determination of dimensions

EN 1015-11, Methods of test for mortar for masonry — Part 11: Determination of flexural and compressive strength of hardened mortar

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

3 Principle

The specimens, after preparation, when needed, are laid and centred on the platen of a compression testing machine. A uniformly distributed load is applied and increased continuously up to failure.

4 Symbols

fb normalized compressive strength of masonry unit (N/mm^2)

d shape factor multiplier used to convert the air-dry compressive strength of the masonry specimens to the normalised compressive strength.

5 Materials

Sand with a maximum grain size of 1 mm.

Cement

6 Apparatus

6.1 Testing machine that conforms to the requirements of Table 1.

Table 1 — Requirements for testing machines

Maximum permissible repeatability of forces as percentage of Indicated force %	Maximum permissible mean error of forces as percentage of Indicated force %	Maximum permissible error of zero force as percentage of maximum force of range %
2,0	±2,0	±0,4

The testing machine shall have adequate capacity to crush all the test specimens, but the scale used shall be such that the failure 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 8.2. The testing machine shall be equipped with two steel-bearing platens. The stiffness of the platens and the manner of load transfer shall be such that the deflection of the platen surfaces at failure load shall be less than 0,1 mm measured over 250 mm. The platens shall either be through hardened or the faces case hardened. The testing faces shall have a Vickers hardness of at least 600 HV when tested in accordance with EN ISO 6507-1.

One platen of the machine shall be able to align freely with the specimens as contact is made, but shall be restrained by friction or other means from tilting during loading. The other platen shall be a plane non-tilting block. The bearing faces of both platens shall be larger than the size of the largest specimen to be tested. Where auxiliary platens are used, they shall be properly located and of the same hardness, stiffness and planeness as the main platens. The bearing surfaces of the platens shall not depart from a plane by more than 0,05 mm.

6.2 Weighing instrument capable of weighing specimens to an accuracy of 0,1 % of their mass.

6.3 Sufficient stiff steel strips for use on shell bedded or strip bedded ground units (See 8.1).

7 Preparation of specimens

7.1 Sampling

The method of sampling shall be in accordance with the relevant part of DKS 2801. The minimum number of specimens shall be six, but a larger minimum number may be specified in the product specification, in which case that larger number shall be used. In the case of large masonry units representative portions, e.g. cubes, may be cut from the masonry unit in different positions as stated in the relevant part of DKS 2801 (see also Note to 7.2.4).

7.2 Surface preparation

7.2.1 General

Specimens shall be tested in the orientation specified, and this shall be stated in the test report. For certain forms of construction, it will be necessary to test the masonry units in more than one orientation. Where grinding in accordance with 7.2.4 significantly alters the contact surface or reduces the height significantly alternative approaches are required, see 7.2.4. Where it is not practicable to prepare clay HD units by grinding e.g. high strength units, the surface preparation may be carried out by capping in accordance with 7.2.5

After the removal of any superfluous material, e.g. flashing from the production process, the faces of the specimen, whether a whole masonry unit or a piece cut from a larger unit (see 7.1), through which the load is to be applied, shall be plane to a tolerance of 0, 1 mm in any 100 mm and such that the top surface lies between two parallel planes which are parallel to the bottom surface, and not greater than 1 mm apart for every 100 mm. If the test faces of the masonry unit as manufactured, or the piece cut from a larger unit, fail to achieve this specification, then prepare the surfaces either by grinding (see 7.2.4) or by capping (see 7.2.5).

Masonry units containing frogs, and not required to be capped, shall additionally be treated as given in 7.2.3.

If the specimens contain grooves or tongues first prepare them as given in 7.2.2. Test specimens shall be prepared in accordance with Annex B.

State the method of surface preparation in the test report.

7.2.2 Removal of tongues and grooves

Remove any tongues and/or grooves on the test faces of units prior to testing. If pieces are to be cut from larger units, arrange the cutting so that any tongues and/or grooves are eliminated.

7.2.3 Preparation of masonry units containing frogs and which are not to be capped

For masonry units with frogs that are assessed to have a net loaded area of more than 35 % of the bed face test them without removing or filling the frogs. Where the net loaded area of masonry units with frogs is less than or equal to 35 % of the gross area then the frogs shall be filled with mortar of the same kind as used for capping (see 7.2.5) and the curing shall be carried out in accordance with the requirements of 7.2.5.4.

7.2.4 Grinding

Grind the surfaces of the specimen until the requirement for planeness and parallelism given in 7.2.1 is achieved. However, if the masonry units have frogs, indented lettering, cavities, perforations, internal or external holes, leave these in place. If the grinding process would significantly alter the contact area of the tested faces then the capping procedure of 7.2.5 shall be followed. If the remaining height of the specimens after they are ground is less than 40 mm or the height /width ratio less than 0,4, then make up a composite specimen by placing one upon the other without using any mortar or binding material or separating layer(s) between them.

NOTE Where a composite specimen is made up from more than one ground unit, this should be considered as a single specimen providing a single test result. Accordingly, a greater number of masonry units than that specifically stated in 2801 will be necessary in order to provide the required number of test results.

7.2.5 Capping

7.2.5.1 Capping of masonry units without voids or with voids unfilled

Use a cement / sand capping mortar expected to attain a minimum compressive strength, when tested in accordance with EN 1015-11, at the time of testing the specimens, at least that of the expected masonry unit strength or 30 N/mm^2, whichever is the lesser.

If necessary, e.g. for units with high water absorption characteristics, first moisten the surfaces to be capped. Bed each specimen on a smooth rigid plate of ground glass or stainless steel which does not depart from a true plane surface by more than 0, 1 mm in any 100 mm. A suitable method is as follows:

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 or plastic film to prevent mortar adhering to the plate. Place a uniform layer of mortar about 5 mm thick on the plate about 25 mm longer than the unit and about 10 mm wider. Press one bed face of the specimen firmly into the layer so that the vertical axis of the specimen is perpendicular to the plane of the plate.

Check this condition by using a square or spirit level held against each of the four vertical faces of the specimen in turn. Ensure that the thickness of the mortar bed is at least 3 mm over the whole area and that any cavity in the bed face normally filled when the masonry units are laid in the wall is completely filled with mortar. Do not fill cavities except for those that are intended to be filled in the construction. Trim off any surplus mortar flush with the sides of the masonry units.

Cover the specimen and mortar with a damp cloth. Keep the cloth damp. When sufficiently hardened, examine the mortar bed. If free from defects such as a lack of compaction, lack of adhesion to the masonry unit and/or cracking, bed the second bed face in the same way as the first, using mortar made with materials drawn from the same batches of cement and sand and using the same mix proportions.

After removing the specimen from the plate, check that the mortar bed is free from defects as before. Small holes may be made in the capping to drain water trapped in cavities, if necessary.

7.2.5.2 Capping of masonry units to be face-shell bedded

When masonry units are to be face-shell bedded in use and specimens are not to be prepared by grinding, bed each specimen in mortar as specified in 7.2.5.1 using the following procedure.

Support and coat the plate as described in 7.2.5.1. Lay two parallel strips of mortar about 5 mm thick such that each strip is about 25 mm longer than the length of the unit and about 10 mm wider than the face shell.

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

Trim off any surplus mortar. Store the specimen, examine and bed the second face in accordance with 7.2.5.1 and 7.2.5.2 respectively.

7.2.5.3 Capping of masonry units to be strip-bedded

When masonry units are to be strip-bedded, the procedure specified in 7.2.5.2 shall be followed except that the capping mortar shall be applied to all of the surfaces to be bedded in use.

7.2.5.4 Storage of capped specimens

Cure the specimens under sacks kept damp throughout the curing period or store in a conditioning chamber at a relative humidity of greater than 90 %. Cure for a period sufficient to ensure the mortar achieves the minimum strength specified in 7.2.5.1.

7.3 Conditioning of specimens before testing

7.3.1 General

Specimens shall be conditioned using a prescribed regime of moisture conditions or to a prescribed moisture condition as appropriate. The method of conditioning shall be as described in this clause. The method shall be as specified in Annex B. In all cases, except for conditioning by immersion, free air circulation around each specimen shall be ensured during conditioning.

7.3.2 Conditioning to the air dry condition

The condition air dry will be achieved in accordance with one of the following procedures:

7.3.2.1 Store the specimens for at least 14 d in the laboratory at:

a) Temperature ≥ 15ºC

b) Relative humidity ≥ 65%

The specimens may be tested before 14 d if constant mass has been reached.

Constant mass shall be considered to have been reached if, during the drying process in subsequent weighing's with not less than a 24 h interval, the loss in mass between two determinations is less than 0,2 % of the total mass.

7.3.2.2 Dry the specimens at 105 °C ± 5 °C for at least 24 h and cool at room temperature for at least 4 h.

7.3.3 Conditioning to the oven dry condition

The condition oven dry will be achieved in accordance with one of the following procedures:

a) Dry the specimens at 105 °C ± 5 °C to constant mass. Constant mass shall be considered to have been reached if, during the drying process in subsequent weighing's with not less than a 24 h interval, the loss in mass between two determinations is less than 0,2 % of the total mass. Allow the specimens to cool to ambient temperature before testing.

b) Dry the specimens at 70 °C ± 5 °C to constant mass. Constant mass shall be considered to have been reached if, during the drying process in subsequent weighing's with not less than a 24 h interval, the loss in mass between two determinations is less than 0,2 % of the total mass. After drying and prior to testing store the specimens at 20 °C ± 2 °C until thermal equilibrium is reached. After that, perform the test within 24 h.

7.3.4 Conditioning to 6 % moisture content

Condition the specimens to a moisture content of 6 % ± 2 % by mass as follows:

Calculate the dry mass of the unit from the volume, which shall be calculated from the dimensions determined as in DKS 2802-8 and the dry density determined in accordance with DKS 2802-7. The mass of the specimen at the time of testing shall be the dry mass multiplied by 1,06. Dry the specimens at a temperature not exceeding 50 °C until this mass is attained with an accuracy of ± 0,2 % of the dry mass.

After conditioning to the 6 % moisture content and prior to testing, store the specimens at room temperature for at least 5 h.

Check and record the mass of the specimen just before testing.

Determine the moisture content in accordance with EN 772-10.

7.3.5 Conditioning by immersion

Immerse the specimens in water at a temperature of 20 °C ± 5 °C for a minimum period of 15 h and subsequently allow them to drain for 15 min to 20 min.

7.4 Loaded area

7.4.1 Gross area

The gross area of the loaded surface shall be calculated in square millimetres by multiplying the length by the width of each specimen determined in accordance with DKS 2802-8. Where units are to be tested with the compressive force other than normal to the bed face, then the gross area shall be calculated similarly but using the width and height or length and height as appropriate.

7.4.2 Net loaded area of units containing frogs intended to be filled with mortar in practice

Where the net loaded area of masonry units with a frog which is intended to be filled with mortar in practice (see also 7.2.3) is not less than 35 % of the gross area then the compressive strength shall be calculated on the basis of the net loaded surface of the frogged bed face. Where the net loaded area of masonry units with a frog is less than 35 % of the gross area then the compressive strength shall be calculated on the basis of the gross area of the masonry unit. In the case of units with frogs in both bed faces the net loaded area to be used shall be the smaller of the two.

Where the frog is of a regular shape, determine the frog area of each specimen by simple measurement and the principles of geometry. For rectangular frogs, determine the frog area of each specimen by measuring the length and width at the outer perimeter of the frog, using a rigid steel rule. Measurements shall be made to the nearest 1 mm. Calculate the net loaded area for each specimen as the difference between the gross area of the bed face and the frog area.

Alternatively, and for units possessing a non-regular frog shape, the net loaded area may be determined by a paper indentation method following the principles of EN 772-2.

8 Procedure

8.1 Placing specimens in the testing machine

Wipe the bearing surfaces of the testing machine (6.1) clean and remove any loose grit from the bed faces of the specimen. Align the specimen carefully with the centre of the ball-seated platen, so that a uniform seating is obtained. Units with a single frog shall be placed with the frog uppermost. Units with a frog in both bed faces shall be placed with the larger frog uppermost.

Do not use any packing material except for units intended to be face-shell bedded or strip-bedded and which have been prepared by grinding. In such cases position four stiff steel strips (6.3), the same width as the face• shells and 50 mm longer, two at the top and two at the bottom, overlapping equally at each end.

8.2 Loading

Initially, use any convenient rate of loading but, when about half the expected maximum load has been applied, adjust the rate so that the maximum load is reached in not less than approximately 1 min. Table 2 is given as a guide to choosing appropriate loading rates.

Record the maximum load achieved.

Table 2 — Loading rate

Expected compressive strength (N/mm^2)	Loading rate (N/mm^2)/s
< 10	0.05
11 to 20	0.15
21 to 40	0.3
41 to 80	0.6
> 80	1.0

NOTE With some specimens, the applied load may fluctuate several times before maximum failure load is reached. This will be indicated by a reduction in load as the specimen yields followed by an increase to a new maximum as loading is continued. This temporary reduction may occur several times before the specimen finally fails.

9 Calculation and expression of results

Calculate the strength of each specimen by dividing the maximum load achieved by its loaded area, which is the gross area for units intended to be laid on a full bed of mortar, to be face shell or strip bedded and those containing frogs not intended to be filled in practice, or in accordance with 7.4.2 in other cases, and express it to the nearest 0, 1 N/mm^2.

10 Evaluation of results

Calculate the compressive strength as the mean value of the strength of the individual specimens to the nearest 0, 1 N/mm^2.

Calculate the coefficient of variation of the sample.

11 Test report

The test report shall contain the following information:

a) number, title and date of issue of this Kenya Standard;
b) name of the organisation that carried out the sampling and the method used;
c) date of testing;
d) type, origin and designation of the masonry unit by reference to DKS 2801;
e) number of specimens in the sample;
f) date of receipt of the specimens in the testing laboratory;
g) a sketch of the specimen, if needed, showing the extent of the loaded area and the height and the orientation of loading;
h) method of conditioning;
i) for those units conditioned to 6 %, the moisture content at the time of testing;
j) method of surface preparation used;
k) failure load in N, and measured dimensions in mm of each specimen;
l) strength of the specimens in N/mm^2, to the nearest 0, 1 N/mm^2, and the coefficient of variation of the sample to the nearest 0.1 %;
m) compressive strength of the sample in N/mm^2, to the nearest 0, 1 N/mm^2;
n) required the value of the normalised compressive strength (see Annex A) in N/mm^2 to the nearest 0,1 N/mm^2;
o) remarks, if any.

