SLS 847 Part 2 : 1989

Sri Lanka Standard

SPECIFICATION FOR CEMENT BRICKS
PART 2 : TEST METHODS

SRI LANKA STANDARDS INSTITUTION

DRAFTING COMMITTEE ON PRECAST MASONRY UNITS

C O N S T I T U T I O N

NAME	ORGANIZATION
Prof. S.R. de S. Chandrakeerthy (Chairman)	University of Moratuwa
Mr. Christopher De Alwis	Amtrad Limited
Mr. V.T.L. Bogahawatte	National Building Research Organization
Mrs. S.B. Ediriweera	Department of Buildings
Mr. G.A.P.H. Ganepola	National Housing Development Authority
Mr. D.M. Jayasekara	Sri Lanka Land Reclamation and Development Corporation
Mr. A.E. de Silva	Personal capacity
Mr. E.J. Sunil Perera	Institute for Construction Training and Development
Mr. L. Tirimanne	State Engineering Corporation
Mr. Y.R. Tilakaratne	National Engineering Research and Development Centre of Sri Lanka
Mr. W. Thiyambarawatte	State Development and Construction Corporation
Mr. D.B. Senadheera (Secretary)	Sri Lanka Standards Institution

Sri Lanka Standard

SPECIFICATION FOR CEMENT BRICKS

PART 2 : TEST METHODS

FOREWORD

This Sri Lanka Standard was authorized for adoption and publication by the Council of the Sri Lanka Standards Institution on 1989-05-12, after the draft, finalized by the Drafting Committee on Precast masonry units, had been approved by the Civil Engineering Divisional Committee.

Cement bricks are preferred over burnt clay bricks for (a) underground applications such as manholes which require good durability and ease of construction; and (b) normal masonry applications in regions of the country where burnt clay bricks are not freely available. Poor quality, arbitrary reduction of size and escalating cost of burnt clay bricks have opened new avenues for greater use of these bricks. Availability of information on hand casting, availability of locally made production equipment for manual and even automatic operation, and ease with which dimensional tolerances and strength requirements can be attained are factors that will lead to further popularization of cement bricks in the future.

A Sri Lanka Standard on cement bricks was considered opportune in order to (a) encourage better quality control; (b) instill greater confidence in designers, manufacturers and users; (c) benefit from knowledge incorporated in similar standards of other countries; and (d) provide procedures for testing.

This part of the standard specifies test methods for the determination of crushing strength, dimensions, density, drying shrinkage, wetting expansion ,absorption and moisture content. Part 1 of the standard deals with requirements for compliance and specifies materials, dimensions, tolerances, strength requirements, physical requirements, sampling and criteria for conformity, and a method of marking.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or an analysis, shall be rounded off in accordance with CS 102. The number of significant figures to be retained in the rounded off value shall be the same as that of the specified value in this standard.

In the preparation of this standard the assistance derived from the publications of the British Standards Institution, the Standards Association of Australia and the American Society for Testing and Materials is gratefully acknowledged.

1 SCOPE

This part of the standard specifies test methods for the determination of crushing strength, dimensions, density, drying shrinkage, wetting expansion, absorption and moisture content.

2 REFERENCE

CS 124 Test sieves.
SLS ~~84~~ 47 Cement bricks : Part 1 : Requirements

3 DEFINITIONS

For the purpose of this specification the following definitions shall apply :

3.1 brick : A masonry unit not exceeding 337.5 mm in length, 225.0 mm in width or 112.5 mm in height.

3.2 fixing brick : A masonry unit of same dimensions as a brick, which permits the easy driving of, and provides a good purchase for, nails or screws.

3.3 types of brick : A solid brick, a perforated brick, a hollow brick and cellular brick.

3.3.1 solid brick : A brick satisfying any of the following conditions:

a) a brick without holes or frogs;
b) a brick having holes (less than 20 mm wide or less than 500 mm^2 in area passing through or nearly through the brick) not exceeding 25 per cent of its volume; and
c) a brick having frog(s) {(depression(s) in the bed face(s) of a brick)} not exceeding 20 per cent of its volume.

NOTE
Other types of bricks such as perforated bricks, hollow bricks or cellular bricks are not covered in this specification.

3.4 size : The co-ordinating size or the work size.

3.4.1 co-ordinating size : The size of a co-ordinating space allocated to a brick, including allowances for joints and tolerances.

3.4.2 work size : The size of a brick specified for its manufacture (to which its actual size should conform within specified permissible deviations).

3.5 height : The vertical dimension of a brick measured perpendicular to the base when the brick is used in its normal aspect.

3.6 length : The larger dimension measured along an edge of a brick in the plane which is used as the base of the brick.

3.7 width : The shorter dimension measured along an edge of a brick in the plane which is used as the base of the brick.

3.8 compressive strength : The average value of the crushing strength of ten or more bricks tested in accordance with 4, provided that the lowest crushing strength of any individual brick is not less than 75 per cent of the average value of the crushing strength of the bricks tested.

NOTE
When the lowest crushing strength of any individual brick does not satisfy the above condition, the compressive strength is taken as 1.33 times the lowest crushing strength of any individual brick.

3.9 drying shrinkage : The difference between the length of a specimen (cut from a block), which has been immersed in water and its length when subsequently dried, all under specified conditions. It is usually expressed as a percentage of the dry length.

3.10 wetting expansion : The difference in length of a specimen when dried to constant length and that when subsequently immersed in water, all under specified conditions. It is usually expressed as a percentage of the dry length.

3.11 brick density : The density calculated by dividing the mass of a block by the overall volume including holes and cavities, if any.

4 DETERMINATION OF CRUSHING STRENGTH

4.1 Apparatus

4.1.1 Two plywood sheets not less than 2.4 mm thick and not more than 4.8 mm thick and of such size to ensure that each plywood sheet extends beyond the face of brick all round the perimeter of each bed face.

4.1.2 A reliable type of testing machine of sufficient capacity for the test and equipped with a means of providing the desired rate of loading indicated in 4.4. The capacity of the machine should be such that the expected ultimate load on a specimen is greater than one-fifth of the machine scale range.

4.2 Test specimens
Ten bricks or such number, taken at random from the sample selected for test (see 12 of SLS 847 Part 1 : 1989), shall be used for determining the crushing strength.

4.3 Preparation of specimens
Each brick shall be immersed in water and maintained at 27 ± 3 °C for a period of at least 24 hours.

4.4 Measurement of crushing strength
Each brick shall be taken out of water about 30 min before it is to be tested and allowed to drain. The specimen shall be tested with load applied perpendicular to the bed face while it is still in a wet condition and crushed between plywood sheets (see **4.1.1**) to take up irregularities. Ensure that the plywood sheets shall extend beyond the faces of the brick all round the perimeter of each bed face. If one bed face contains a frog, that bed face shall be placed uppermost .

The load shall be applied axially at any convenient rate up to about one-half of the expected maximum load and thereafter, at a uniform rate such that the remaining load applied is not less than 2 minutes.

Record the maximum load, in newtons, carried by the specimen before failure.

4.5 Calculation of crushing strength

4.5.1 Where no frog or similar indentation is present, calculate the area of the smaller bed face of the specimen. Where there is a frog, calculate the gross area of the bed face on which the frog lies and calculate the net area of application of the load, as the gross area minus the area of the frog.

Where both bed faces contain frogs, calculate the area of the smaller net bed face as above.

4.5.2 Obtain the crushing strength of each specimen by dividing the maximum load from **4.4** by the area of the bed face measured in **4.5.1.**

4.5.3 Calculate the average crushing strength of the sample to the nearest Ø.5 N/mm^2.

4.6 Reporting of results
Report the arithmetic mean and the minimum value of the crushing strength of the sample.

5 DETERMINATION OF DIMENSIONS

5.1 Apparatus

5.1.1 Callipers, of such size and shape that can be used to measure the brick.

5.1.2 A rule, graduated to 1 mm, for use with the callipers.

5.2 Test specimens

Take at random 20 bricks, or such number as sampled in accordance with **12 of SLS 647: Part 1 : 1989.** Before measuring a brick, remove any flashings preferably with a carborundum stone.

5.3 Length

Using the callipers and the rule, measure the length of each brick to the nearest millimetre at the four locations shown in Figure 1 (a).

Record each result.

Calculate the average of the four results to the nearest millimetre.

5.4 Height

Using the callipers and the rule, measure height of each brick to the nearest millimetre, at the four locations shown in Figure 1 (b).

Record each result.

Calculate the average of the four results to the nearest millimetre.

5.5 Width

Using the callipers and the rule, measure the width of each brick to the nearest millimetre, at the four locations shown in Figure 1 (c).

Record each result.

Calculate the average of the four results to the nearest millimetre.

6 DETERMINATION OF DENSITY

6.1 Apparatus

6.1.1 Callipers, as described in **5.1.1**

6.1.2. A rule, as described in **5.1.2**

6.1 Oven, ventilated, capable of controlling the temperature at 105 ± 5 °C.

6.2 Test specimans

Select the number of bricks as specified for density measurements in **12.3.2 of SLS .. : Part 1 : 1989.**

6.3 Density

Dry the brick for at least 16 hours in the ventilated oven having the temperature controlled at 105 ± 5 °C.

Allow the brick to cool to the ambient temperature and weigh.

Repeat these steps until the mass lost in one cycle does not exceed 0.05 kg.

Calculate the density of brick using the formula :

$$\rho = \frac{m}{V}$$

where,

ρ is the density of brick in kg/m³
m is the oven dry mass in kg ; and
V is the volume in m³

7 DETERMINATION OF DRYING SHRINKAGE

7.1 Apparatus

7.1.1 Measuring apparatus
A measuring apparatus shall be used which incorporates a micrometer gauge or a suitable dial gauge reading accurately to Ø.ØØ2 5 mm. This gauge shall be rigidly mounted in a measuring frame and have a flat or a recessed end which may be located upon a 5 ± Ø.1 mm diameter ball or a 6.4 ± Ø.1 mm diameter ball or other reference point providing a hemispherical bearing cemented on the specimen. The other end of the frame shall have a similar flat seating or recessed seating which may be located upon the other ball or reference point in the specimen.

An invar steel rod which shall be used as a standard length against which readings of the gauge may be tested, thus enabling corrections to be made for any change in the dimensions of the apparatus between successive measurements of a test specimen.

The invar steel rod shall be of suitable length and shall have the following end conditions :

a) 5 ± Ø.1 mm diameter or 6.4 ± Ø.1 mm diameter hemispherical ends ; or
b) 5 ± Ø.1 mm diameter polished steel balls or 6.4 ± Ø.1 mm polished steel balls mounted on the ends ; or
c) hemispherical machined ends of diameter greater than 6.4 mm to an accuracy of Ø.1 mm. (When this arrangement is used the flat surfaces of the apparatus, which hold the invar steel rod, should also hold the reference point of the specimen.)

The apparatus should preferably be adjusted for specimens of different lengths and an invar rod of length near to those of the specimens to be tested should be available.

A convenient form of a measuring apparatus suited for fabrication is shown in Figure 2. Alternatively other types, produced by reputed manufacturers, complying with the above requirements may be used.

7.1.2 Drying Oven

7.1.2.1 It shall have an internal volume equivalent to not less than 8 litres per specimen, with a minimum total volume of 5Ø litres.

7.1.2.2 It shall be reasonably air-tight and shall be provided with a fan to keep the air circulating effectively during the drying of the specimen.

7.1.2.3 It shall be maintained at a temperature of 50 ± 1 °C.

7.1.2.4 The humidity of the air in the oven shall be controlled at approximately 17 per cent relative humidity by means of saturated calcium chloride solution. Suitable dishes or trays containing this solution shall be provided to give an exposed area of solution not less than 1 000 mm^2 for each litre of volume of the oven. The dishes or trays shall contain sufficient solid calcium chloride to show above the surface of the solution throughout the test.

7.1.3 Rule
A rule graduated to 1 mm.

7.2 Test specimens

7.2.1 Of the sample selected in accordance with **12** of **SLS 817 Part 1 : 1989**, three bricks, or such number taken at random for the sample shall be used for testing drying shrinkage. Three more bricks shall be set aside and stored in air_tight containers at normal room temperature so as to be available for duplicate tests if they are required at a later stage (see Note below).

One test specimen is cut from each selected brick as described in **7.3**.

NOTE
In order to facilitate storage, it will be considered that this condition is satisfied if sections cut from these additional bricks are stored until necessary in separate air-tight containers at normal room temperature.

7.3 Preparation of specimens

7.3.1 One specimen shall be cut from each of the bricks such that the length of each specimen is not less than 150 mm and the cross-section is as near as practicable to 50 mm x 25 mm or 50 mm x 50 mm.The central area of the rectangle enclosing the cross-section of the specimen shall be solid. Alternatively a whole brick can be tested. Two reference points as described in **7.1.1** shall be cemented with neat rapid-hardening cement or neat ordinary Portland cement or other suitable cementing material such as a synthetic resin, at the centre of each end of the specimen after drilling or cutting a shallow depression. After fixing, the surface of the steel balls shall be wiped clean of cementing material and dried and coated with lubricating grease to prevent corrosion.

When rapid hardening cement or ordinary Portland cement is used, the specimen shall be stored in moist air for at least one day or seven days respectively. When synthetic resin is used, the surface of sample shall be kept dry during hardening for a time period specified by the resin manufacturer.

The specimen shall then be completely immersed in water at room temparature for four to seven days, the temperature being maintained at 27 ± 3 °C at least for the last four hours.

7.4 Measurement of drying shrinkage

7.4.1 Immediately after removal of the specimens from the water, the grease shall be wiped from the steel balls and the length of each specimen measured to an accuracy of Ø.ØØ2 5 mm by the apparatus described in **7.1.1.** Rotate the specimen in the frame and observe the minimum reading. Then reverse the specimen end to end and observe the minimum readings in the same way. Determine the average of the two readings. This shall be taken as the original wet measurement (This need not be done if reference points are held by flat ends in a stable manner).

Before and after each set of specimens is measured check the reading of the measuring apparatus using the Invar rod. If the readings differ by more than Ø.ØØ5 mm repeat the measurement, identify the cause of the error and take remedial action. When the readings do not differ by Ø.ØØ5 mm record the average of the two readings taken with the reference rod.

NOTE
The instrument reading is not the absolute length of the specimen but the difference in length between the specimen and the invar rod of approximately the same length.

7.4.2 The specimen shall then be dried for at least 44 hours in the oven as described in **7.1.2.** It should be noted that during the drying process additional wet specimens shall not be placed in the same oven and there shall be free access of air to all surfaces of the specimen. The specimens shall then be removed from the oven and cooled for at least 4 hours in a desiccator containing solid calcium chloride or a saturated solution of calcium chloride. Each specimen shall then be measured as described in **7.4.1,** at a temperature of 27 ± 3 °C.

7.4.3 This cycle of drying, cooling and measuring shall be repeated until constant length is attained. That is when the difference between two consecutive measurements is less than 0.005 mm for a 150 mm specimen and pro rata for a larger specimen. The last measurement taken is the dry measurement. Make a correction to the measurement of length of the specimen for any apparent change in the length of reference rod between wet and dry measurements. If the above correction is applicable then the corrected final measurement shall be taken as the dry measurement.

7.4.4 After the dry measurement has been taken, the length of the specimen shall be measured, adjacent to the steel balls, to the nearest one millimetre and this shall be taken as the dry length.

NOTE
The duration of the drying process in this test may be about two to three weeks.

7.5 Calculation of results
The drying shrinkage shall be calculated for each specimen as the difference between original wet measurement and the dry measurement expressed as a percentage of the dry length.

7.6 Reporting of results
Calculate the average value of drying shrinkage of the three specimens or such number to the nearest 0.005 per cent. If the value for drying shrinkage obtained with any one of the specimens differs from the average value by more than 25 per cent or if one or more specimens from the original sample of specimens be so damaged that no value can be obtained, further specimens should be tested.

8 DETERMINATION OF WETTING EXPANSION

8.1 Apparatus
The Apparatus used shall be the same as that described in 7.1.

8.2 Test specimens

Three specimens or such number which have previously been used for the drying shrinkage test (see 7) shall be tested.

8.3 Preparation of specimens
The specimens shall be prepared as described in **7.3.**

8.4 Measurement of wetting expansion
Test the specimens for drying shrinkage, first as described in **7.4** and determine the dry measurement. Then coat the steel balls with lubricating grease and keep the specimen immersed in water at room temperature for four days, and at least for the last four hours the temperature should be maintained at 27 ± 3 °C. Immediately after removal of the specimens from the water, wipe the grease from the steel balls and obtain two readings for each specimen as described for determining the original wet measurement (see **7.4.1**). Average of the above two readings is taken as the wet measurement. Make a correction to the wet measurement of the length of specimen for any apparent change in the length of the reference rod between the dry measurement and the wet measurement. The corrected wet measurement should be taken as the final wet measurement.

8.5 Calculation of results
The wetting expansion for each specimen shall be the difference between the final wet measurement and the dry measurement and expressed as a percentage of dry length. (see **7.4.4**)

8.6 Reporting of results
Calculate the average value of wetting expansion of the three specimens or such number to the nearest Ø.ØØ5 per cent. If the value for wetting expansion obtained with any one of the specimens differs from the average value by more than 25 per cent or if one or more specimens from the original sample of specimens be so damaged that no value can be obtained, further specimens should be tested.

NOTE
In repeating this wetting expansion test, the drying shrinkage test shall be repeated if the previous specimens have failed on that test as well. Otherwise the drying shrinkage test may be omitted. The three new specimens or such number, in that event, shall be dried to constant length at 5Ø ± 1°C measured after cooling (similar to the drying shrinkage test without the wet measurment), and the wetting expansion test carried out as described in **8.4.**

9 DETERMINATION OF ABSORPTION AND MOISTURE CONTENT

9.1 Apparatus

9.1.1 A balance, sensitive to within Ø.5 per cent of the mass of the smallest specimen tested.

9.1.2 Oven, ventilated, capable of controlling the temparature between 1ØØºC and 115ºC.

9.2 Test specimens

Bricks of such number as specified in Table 4 of **SLS 817 : Part 1 : 1989,** selected for the determination of absorption and moisture content as described in **12.3.2 of SLS 817 : Part 1 : 1989** shall be used.

9.3 Preparation of specimens

The surfaces of the specimens shall be cleaned free of dust and other adhering foreign matter, without damaging the surface texture of the specimens.

9.4 Procedure

9.4.1 Original mass of brick

The specimen shall be weighed after preparation as in 9.3 taking care not to alter the moisture content.

9.4.2 Submerged mass of brick

The test specimens shall be completely immersed in potable water at 27 ± 3 ºC for 24 hours. The specimens shall then be weighed while completely submerged in water.

9.4.3 Wet mass of brick

The specimens shall be removed from the water and allowed to drain for one minute by placing them on a 1Ø mm or coarser wire mesh. The water on the surfaces shall be removed with a damp cloth and the specimens immediately weighed.

9.4.4 Dry mass of brick

Subsequent to saturation, all specimens shall be dried in the ventilated oven at 1ØØ ºC to 115 ºC for not less than 24 hours and weighed. If two successive weighings at intervals of two hours show an increment of loss not greater than Ø.2 per cent of the former value, then the latter value shall be taken as the dry mass of the brick.

9.5 Calculation of results

Calculate the absorption and moisture content as follows :

i) absorption, kg/m³ of net volume $= \frac{m_4 - m_2}{m_1 - m_3} \times 10^3$

ii) moisture content, per cent based on maximum possible moisture in the block $= \frac{m_4 - m_2}{m_1 - m_2} \times 100$

iii) water absorption, per cent $= \frac{m_1 - m_2}{m_2} \times 100$

where,

m_1 = wet mass of brick in kg ;
m_2 = dry mass of brick in kg ;
m_3 = submerged mass of brick in kg ; and
m_4 = original mass of brick in kg.

NOTE

Water absorption is not a physical requirement as specified in 10 of **SLS 847 : Part 1 : 1989**, however, it is an useful index to determine whether wetting of bricks is necessary before bricklaying.

9.6 Reporting of results

Report the absorption and moisture content separately for each brick and also as the average for the sample.

- Blank Page -