SRI LANKA STANDARD 855 : PART 2 : 1989

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SPECIFICATION FOR

CEMENT BLOCKS

PART 2 - TEST METHODS

SRI LANKA STANDARDS INSTITUTION

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SLS 855 : Part 2 : 1989

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SRI LANKA STANDARD
SPECIFICATION FOR CEMENT BLOCKS
PART 2 : TEST METHODS

FOREWORD

This Standard was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 89-07-25, after the draft, finalized by the Drafting Committee on Precast masonry units, had been approved by the Civil Engineering Divisional Committee.

Cement blocks are available as solid blocks, hollow blocks and cellular blocks, and commonly made of cement sand mixes or concrete mixes. Although they are of recent origin compared to other building materials such as stone and brick, the demand in the construction industry for these blocks is significant at present.

Popularity has led to greater use, which in turn has stimulated the use of hand casting and machine casting. Further, more and more manufacturers are taking up production of cement blocks and this trend may continue as these products become popular throughout the country. Production of a great diversity of blocks with varying sizes and tolerances, and varying properties can be harmful in the long term. Use of cement blocks in high strength applications also necessitates the need for careful quality control and regular testing of blocks. Due to more favourable environmental conditions and the common building types prevalent in Sri Lanka, strength and physical requirements can also be altered compared to those specified internationally. Thus a strong need exists for a specification for cement blocks to attain higher performance levels and greater safety, to standardize on size and tolerances of blocks, and to conduct necessary testing.

This part of the standard specifies test methods related to cement blocks. Part 1 of this standard deals with requirements of solid blocks, hollow blocks and cellular blocks.

In reporting the result of a test or analysis made in accordance with this standard if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with CS 102.

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

1 SCOPE

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

2 REFERENCES

CS 102 Presentation of numerical values.
CS 124 Test sieves.
SLS 855 Cement blocks : Part 1 : Requirements

3 DEFINITIONS

For the purpose of this specification the following definitions given in SLS 855 : Part 1 : 1989 shall apply.

4 DETERMINATION OF CRUSHING STRENGTH OF BLOCKS

4.1 Apparatus

4.1.1 Steel capping plates machined on one side to give a smooth plane surface, at least 25 mm longer and wider than the block to be capped, not less than 19 mm thick or sheets of glass at least 9 mm thick, ground to a flatness tolerance of 0.1 mm on one side.

4.1.2 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 block all round the perimeter of each bed face.

4.1.3 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 4.4.1. 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 whole blocks or such number taken at random from the sample selected for test (see 12 of SLS 855 : Part 1 : 1989), shall be used in determining the crushing strength.

4.3 Preparation of specimens

4.3.1 Each block shall be immersed in water, maintained at 27 ± 3 ^{0}C for a period of 24 hours and then bedded with cement sand mortar as described in 4.3.2.

4.3.2 A steel plate/glass sheet as specified in 4.1.1 shall be firmly supported with the machined/ground surface uppermost and levelled in two directions at right angles with a spirit level. The machined/ground surface shall be coated with a film of mould oil to prevent mortar adhering to it. A layer of cement sand mortar composed of one part of cement to one part of clean sand, by mass, having particle size of 3.2 mm and below with a water cement ratio of not more than 0.35 shall then be placed on the plate/sheet. One bed face of the specimen shall be firmly pressed in to the layer of mortar, so that the vertical axis of the specimen is perpendicular to the plane of the plate/sheet. This condtion shall be checked using a square or a vertical level held against each of the four vertical faces of the specimen in turn, making allowance for any taper on the block sides.

The mortar bed shall, at no point, be less than 6 mm clear of the block. Any cavity in the bed face (one of the surfaces of block that would normally be placed horizontally in wall), which is normally filled when the units are laid in the wall, shall be completely filled with mortar (see Note 1 below). However, blocks in which cavities are not intended to be filled, shall be capped only to cover the solid cross-section of the shell.

The surplus mortar shall be trimmed off flush, with the sides of the block. The unit and mortar shall then be covered with a damp cloth and kept undisturbed for a minimum period of 24 hours. The bedded block shall be carefully removed from the steel plate/glass sheet without damaging the mortar and inverted, and the second bed face bedded in the same manner as the first, using the same cement sand mix and water cement ratio as before. The two mortar faces shall be made parallel to each other by levelling the specimen in two directions at right angles on the second mortar layer by means of the spirit level on the face of the now uppermost first mortar facing. After bedding, the block shall again be covered with a damp cloth for further 24 hours and then immersed in water until tested. The period of immersion (see Note 2 below) shall be such that mortar cubes (70.6 mm each side) made from the same batch used for bedding the second bed face and stored under identical conditions shall have a crushing strength of not less than 28 N/mm^{2} and not more than 42 N/mm^{2}.

NOTES

1. This requirement shall not be taken as requiring the filling of cavities which are made in the blocks to give a light-weight wall.

2. Under normal wet storage conditions, this usually entails a period of 3 to 7 days.

3. The capping may be omitted by agreement between the purchaser and the manufacturer, and may result in a lower value for the compressive strength of the sample. Even in this case, the compressive strength shall comply with 9 of SLS 855 : Part 1 : 1989.

4.4 Measurement of crushing strength

4.4.1 When the crushing strength of mortar cubes has attained the required value of not less than 28 N/mm^2 and not more than 42 N/mm^2 the specimen shall be removed about 30 min before it is to be tested and allowed to drain. The specimen shall be tested while it is still in a wet condition and crushed between plywood sheets (see 4.1.2). Ensure that the plywood sheets shall extend beyond the faces of the block all around the perimeter of each bed face. 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 is applied in not less than two minutes.

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

4.5 Calculation of crushing strength

4.5.1 Calculate the gross area of a block to the nearest 500 mm^2 using the results obtain from 5.

4.5.2 The maximum load recorded in 4.4 divided by the gross area of the block in square millimetres shall be taken as the crushing strength of the block. (see also Notes under 9 of SLS 855 : Part 1 : 1989 and 6.6 of the standard).

4.6 Reporting of results

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

5 DETERMINATION OF DIMENSIONS OF BLOCKS

5.1 Apparatus

5.1.1 *Callipers,* of such size and shape that can be used to measure the external shell thickness of the block.

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

5.2 Test specimens
Take at random 20 blocks, or such number as sampled in accordance with 12 of SLS 855 : Part 1 : 1989. Before measuring a block, remove any flashings preferably with a carborundum stone.

5.3 Length
Using the rule, measure to the nearest millimetre, the length of each block at the four positions shown in Figure 1 (a).

Record each result.

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

5.4 Height
Using the rule, measure to the nearest millimetre, the height of each block at the six positions shown in Figure 1 (b).

Record each result.

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

5.5 Width
Using the callipers and the rule, measure to the nearest millimetre, the width of each block at seven positions shown in Figure 1 (c).

Record each result.

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

5.6 Minimum external face shell thickness and minimum web thickness
Using the callipers and the rule, measure to the nearest millimetre, the minimum face shell thickness of each block at its thinnest points.

Record each result.

Calculate the average minimum face shell thickness of the sample of blocks to the nearest millimetre.

Adopt a similar procedure to determine the minimum web thickness.

5.7 Width of cavities
Select by inspection, in each of the blocks a line perpendicular to the block face, where the total width of cavity/cavities is a maximum. Measure at this position the total width of cavity/cavities by using a suitable calliper. The calliper should not be allowed to bed into surface irregularities and should 'feel' the wall surfaces smoothly for a stroke of 10 mm to 15 mm.

Record, to the nearest 1 mm, the total width of cavity/cavities in each block.
Express the total width of cavity/cavities as a percentage of the block width at the same position in each block.

Record, to the nearest 5 per cent, the greatest width of cavity/cavities observed.

6 DETERMINATION OF VOLUME OF CAVITIES, DENSITY AND NET AREA OF BLOCKS

6.1 Apparatus and material

6.1.1 *Test sieves,* of size 300 m and 600 m complying with CS 124.

6.1.2 *Sand,* graded dry.

6.1.3 *Measuring cylinder,* of glass graduated to 50 ml and of capacity 1 litre.

6.1.4 *Callipers,* as described in 5.1.1.

6.1.5 *A rule,* as described in 5.1.2.

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

6.2 Test specimens
Select the number of blocks as specified for density measurements in 12.3.2 of SLS 855 : Part 1 : 1989.

6.3 Volume of cavities (V_2)

Place the block on a thin sheet of foam rubber or other resilient material with the open ends of the cavities uppermost.

Close any cavities at the ends of the block by clamping flat sheets of 13 mm insulating board to the ends of the block without distortion. Ignore the effects of tongues or grooves.

Fill the one litre glass measuring cylinder with dry sand which has been graded between a 300 m test sieve and a 600 m test sieve.

Fill the cavities with the sand by pouring from the cylinder, refilling it if required, keeping the cylinder lip within 25 mm of the top of the cavity and pouring steadily and striking off level.

Return to the cylinder any sand struck off and note, in ml the total volume of sand used to the nearest 50 ml.

Convert this volume to the equivalent volume, in mm^3, of the cavities to the nearest 250 mm^3. Calculate the gross volume of the block to the nearest 250 mm^3 by multiplying the average width (see 5.5) by the length and height of the block. (Ignore formed protrusions and indentations).

Express the volume of cavities in each block as a percentage of the gross volume of the block.

Record to the nearest 5 per cent the greatest volume of cavity observed.

6.4 Concrete volume (V_c)

Remove all random flashings with a carborundum stone.

Measure to the nearest 1 mm, using callipers and rule as described in 5, the dimensions of formed indentations and protrusions on the external faces and ends of the block.

Calculate the algebraic sum of the volume of indentations and protrusions to the nearest 250 mm^3. (Treat volume of indentations as negative and volume of protrusions as positive.)

Calculate the concrete volume, to the nearest 250 mm^3, using the formula :

$$V_c = V_1 - V_2 + V_3$$

Where,
V_c is the concrete volume in mm^3 ;

V_1 is the gross volume of the block in mm^3 ;

V_2 is the volume of cavities and voids in mm^3 ; and

V_3 is the algebraic sum of volume of indentations and protrusions in mm^3.

6.5 Block density and concrete density
Dry the block for at least 16 hours in the ventilated oven having the temperature controlled at 105 ± 5 °C.

Allow the block 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 block density and the concrete density by using the formulae :

$$\rho_b = \frac{m}{V_1}$$

where,
ρ_b is the block density kg/m^3 ;

m is the oven dry mass in kg ; and

V_1 is the gross volume in m^3.

$$\rho_c = \frac{m}{V_c}$$

where,

ρ_c is the concrete density in kg/m^3;

m is the oven dry mass in kg; and

V_c is the concrete volume in m^3

Record the block density and concrete density as the respective means, to the nearest 10 kg/m^3, obtained for the sample.

NOTES

1. The block density normally falls within 1000 kg/m^3 and 2800 kg/m^3 and it is required for evaluating self weight of masonry.

2. The concrete density gives a measure of compaction of concrete. When lightweight aggregates are used, it also indicates the extent of reduction of weight achieved.

6.6 Net area of hollow blocks

Obtain the mean height from six height measurements using the method of measurement of height described in 5.4

Calculate the net area using the following formula :

$$A = \frac{V_c}{h}$$

where,

A is the net area in mm^2 ;

V_c is the concrete volume in mm^3 ; and

h is the mean height in mm.

Record the net area as the mean, to the nearest 1 mm^2, obtained for the sample.

NOTE - The net area of hollow block is required for assessing the characteristic compressive strength of walls of hollow concrete blocks filled with in-situ concrete. The term characteristic compressive strength of a block wall is used in structural design and has no relevance to this standard which deals with cement blocks.

7 DETERMINATION OF DRYING SHRINKAGE OF BLOCKS

7.1 Appratus

7.1.1 *Measuring apparatus*
A measuring apparatus shall be used which incorporates a micrometer gauge or a suitable dial gauge reading accurately to 0.002 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 $\pm$ 0.1 mm diameter ball or a 6.4 $\pm$ 0.1 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) with 5 $\pm$ 0.1 mm diameter or 6.4 $\pm$ 0.1 mm diameter hemispherical ends ; or
b) with 5 $\pm$ 0.1 mm diameter polished steel balls or 6.4 $\pm$ 0.1 mm polished steel balls mounted on the ends; or
c) with hemispherical machined ends of diameter greater than 6.4 mm to an accuracy of 0.1 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 50 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 $\pm$ 1 ^{o}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 855 : Part 1 : 1989, three blocks or such number taken at random for the sample shall be used for testing drying shrinkage. Three more blocks 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 block 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 blocks 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 blocks 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. 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 $\pm$ 3 ^{o}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 0.002 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 reading 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 0.005 mm repeat the measurements and identify the cause of the error and take remedial action . When the readings do not differ by 0.005 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 apparant 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 takern 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 OF BLOCKS

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 specimens immersed in water at room temperature for four days,and at least for the last four hours temperature of the water 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 0.005 per cent. If the value for wetting expansion obtained with any one of the specimens differ 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 50 ± 1°C measured after cooling (similar to the drying shrinkage test without the wet measurement), 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 0.5 per cent of the mass of the smallest specimen tested.

9.1.2 *Oven,* ventilated, capable of controlling the temperature between 100 °C and 115 °C.

9.2 Test specimens

Blocks of such number as specified in Table 5 of SLS 855 : Part 1 : 1989 selected for the determination of absorption and moisture content as described in 12.3.2 of SLS 855 : 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 block*

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

9.4.2 *Submerged mass of block*

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

9.4.3 *Wet mass of block*

The specimens shall be removed from the water and allowed to drain for one minute by placing them on a 10 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 block*

Subsequent to saturation, all specimens shall be dried in the ventilated oven at 100 °C to 115 °C 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 0.2 per cent of the former value, then the latter value shall be taken as the dry mass of the block.

9.5 Calculation of results
Calculate the absorption and moisture content as follows :

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

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

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

where,

m_1 = wet mass of block in kg ;

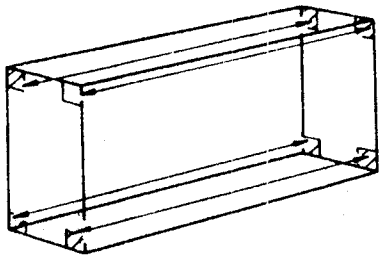
m_2 = dry mass of block in kg ;

m_3 = submerged mass of block in kg ; and

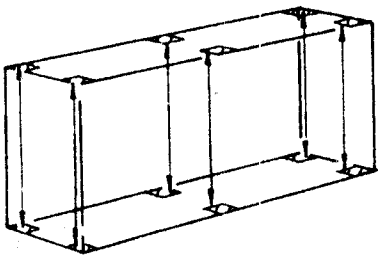
m_4 = original mass of block in kg.

NOTE - Water absorption is not a physical requirement as specified in 10 of SLS 855 : Part 1 : 1989 however, it is an useful index to determine whether wetting of blocks is necessary before blocklaying.

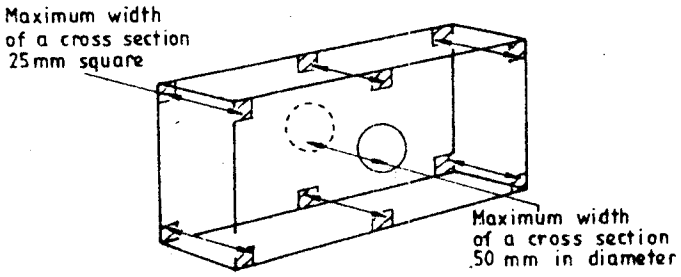
9.6 Reporting of results
Report the absorption and moisture content separately for each block and also as the average for the sample.



(a) Four positions for measurement of length of whole blocks



(b) Six positions for measurement of height of whole blocks



(c) Seven positions for measurement of width of whole blocks

FIGURE 1 - Measuring dimensions of blocks

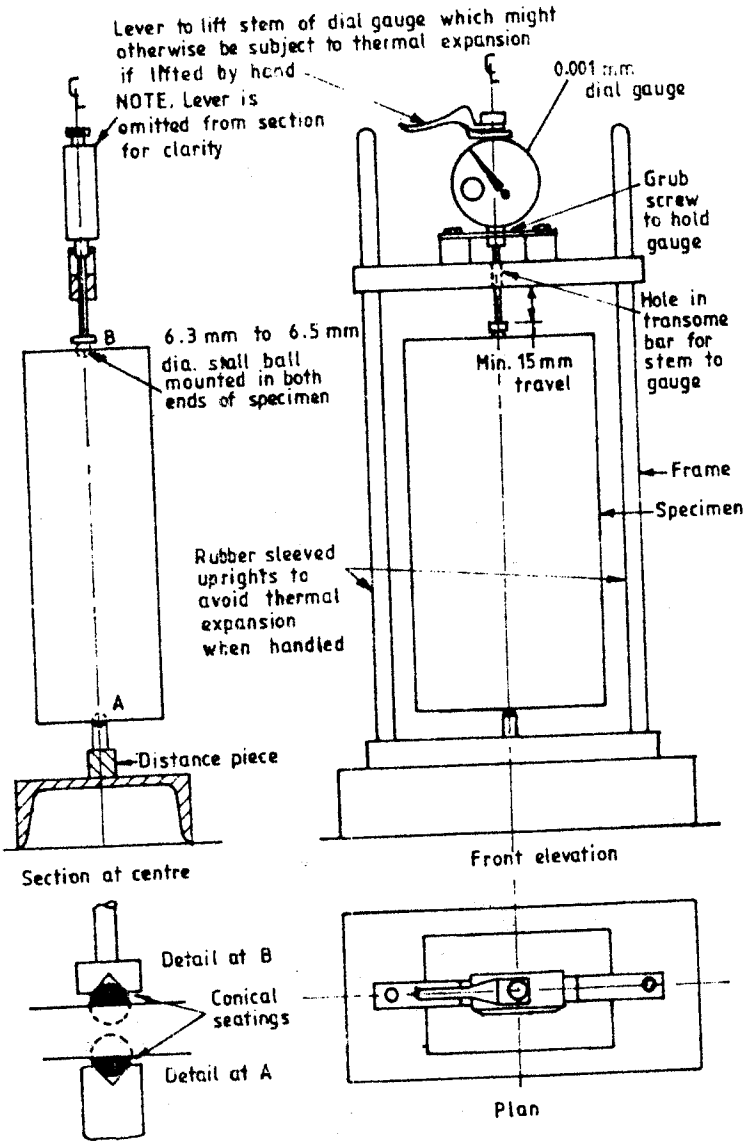


FIGURE 2 -Typical measuring apparatus for drying shrinkage

SRI LANKA STANDARDS INSTITUTION

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