SRI LANKA STANDARD 943 : 1991

UDC 621.742.4

METHODS OF PHYSICAL TEST FOR

FOUNDRY SANDS

SRI LANKA STANDARDS INSTITUTION

METHODS OF PHYSICAL TEST FOR FOUNDRY SANDS

SLS 943 : 1991

Gr. 16

SRI LANKA STANDARDS INSTITUTION
53, Dharmapala Mawatha,
Colombo 3,
Sri Lanka.

SRI LANKA STANDARD
METHODS OF PHYSICAL TEST FOR FOUNDRY SANDS

FOREWORD

This Standard was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 91.11.14 after the draft, finalized by the Drafting Committee on foundry Industry had been approved by the Mechanical Engineering divisional committee.

All the values given in this standard are in SI units.

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 observation shall be rounded off in accordance with CS 102. The number of figures to be retained in the rounded off value shall be the same as that of the specified value in this standard.

The Sri Lanka Standards Institution gratefully acknowledges the use of relevant publications of the Bureau of Indian Standards in the preparation of this standard.

1 SCOPE

1.1 This standard specifies the methods of physical test for foundry sands to evaluate their properties under standard conditions.

2 REFERENCES

CS	102	Presentation of Numerical values
CS	124	Test Sieves
SLS	937	Methods of sampling foundry sand

3 DEFINITIONS

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

3.1 **foundry moulding sand** : A mixture of high silica sand, natural sand, synthetic sand and reclaimed sand and clay.

3.2 **core sand** : Sand that is suitable for making cores, usually low in clay substances.

3.3 **moisture content**: Amount of moisture in the sand expressed as a percentage.

3.4 **clay content** : Amount of clay in the sand expresed as a percentage.

3.5 **grain fineness number** : An expresion for the size of grain of sand and calculated as the surface area per unit mass of sand.

3.6 **grain shape** : The shape of sand grains.

3.7 **permeability** : The property of the moulding sand which allows gas to pass trough it.

3.8 **base permeability** : Permeability of packed dry sand grains containing no clay or other bonding substances.

3.9 **green permeability** : Pemeability of a moulding sand in its wet condition.

3.10 **dry permeability** : Permeability of a moulding sand, in the dry condition.

3.11 **baked permeability** : Permeability of a moulded mass of sand baked at a temperature higher than 110 °C and then cooled to room temperature .

3.12 **green compression strength** : The maximum compressive stress which the sand in the wet state is capable of withstanding.

3.13 **dry (baked) compression strength** : The maximum compressive stress which a dry sand mixture is capable of withstanding.

3.14 **green shear strength** : The maximum shear stress which the wet sand mixture is capable of developing.

3.15 **dry shear strength** : The maximum shear stress which a dry sand mixture is capable of developing.

3.16 **Bulk density** : The ratio of the mass of the specimen to the volume.

3.17 **green mould surface hardness** : The resistance offered by the surface of a green sand mould to penetration by a loaded plunger.

3.18 **flowability** : The movement of sand grains when they are subjected to moulding forces.

3.19 **shatter index** : The percentage retention of a rammed mass of sand on a given size of sieve when dropped on to the sieve from a prescribed height.

3.20 **sintering point** : The temperature at which fusing of sand grains with each other occurs when subjected to high temperature.

3.21 **baked tensile strength** : The maximum tensile stress which a core sand mixture will develop in the baked condition.

3.22 **baked transverse strength** : The load per unit area required to break a standard test bar of specified dimensions made out of core-sand mixture, when the load is applied midway between the ends of the test bar.

3.23 **baked scratch hardness** : A measure of the ability of the core to withstand abrasion during the handling operation from the baking oven to the mould.

SECTION 1 : GENERAL

4 SAMPLING

4.1 Representative samples shall be drawn according to the scheme of sampling given in SLS 937

5 PREPARATION OF FOUNDRY SAND FOR TESTING

5.1 Preparation of High-Silica Sand

The samples in accordance with 4.1 shall be used without any processing.

5.2 Preparation of natural moulding sand

5.2.1 *Tempering manually*

Dry about 2 kg sample of sand for one hour at 105°C to 110°C. Spread the sand over a large area in a thin layer so that all moisture is expelled in the given time. After allowing the sand to cool down to room temperature, measure the quantity of water needed to give the desired moisture content (in terms of percent mass of tempered mix), adding little extra water (usually from 0.25 to 1.0 percent) to allow for evaporation. Spread the sand on a smooth, flat, dry, non-absorbent surface in a layer about 25 mm thick. Sprinkle a small quantity of the water from the measured quantity evenly over the sand and work the sand gradually. Spread again the sand into a thin layer and repeat the above operations, adding more water. Repeat the process until all the water has been thoroughly distributed in the sand. There should be no dry lumps or other evidence of uneven tempering.

5.2.2 *Alternate method of tempering manually*

In case sand has a lower moisture content than desired, it need not be dried before tempering. Add sufficient water to bring the sand to the desired moisture content. In case the sand has a higher moisture content than desired, the sand shall be partially dried, allowed to cool and then tempered with sufficient water to bring the moisture to the desired value.

5.2.3 *Tempering by mechanical mixing*

Dry about 2 kg sample of sand as given in 5.2.1. Place the dried sand in the laboratory mixer and add sufficient water to produce the desired moisture content plus an additional amount to allow for evaporation during mixing. Water should be added gradually within 30 seconds while the mixer is operating. Total mixing time should be 5 minutes.

NOTE

Any one method of tempering shall be followed throughout to prepare sand mixture of same or different moisture contents during the course of an investigation for evaluating a sand sample.

5.3 **Preparation of synthetically bonded sand mixture**

Test samples of synthetically bonded sand mixture shall be prepared in a mechanical mixer. Dry about 2 kg of sand for one hour at 105°C to 110°C. Spread the sand over a large area in a thin layer so that all moisture is expelled in the given time. After drying and cooling to room temperature, weigh the correct amounts of sand or sands, and bond or bonds, as used in the foundry mixtures. Place the dried sand and then the dried bonding materials, in the mixer. Place the cover on the mixer, start the mixer and mix for two minutes. Following the two-minute mixing period, allow two minutes for dust to settle before removing the mixer cover. Add the required amount of water gradually within 30 seconds to give the required moisture percentage plus sufficient additional water to allow for evaporation during mixing. Mix for a period of 5 minutes. Remove the sand from the mixer as quickly as possible. Allow samples to stand in an air-tight container for two hours before testing.

NOTE

Variation in physical properties with moisture content shall be determined by giving small increments to water content (say 0.5 to 1.0 per cent).

6 PREPARATION OF STANDARD TEST SPECIMEN

6.1 Apparatus

Standard sand rammer, standard steel specimen tube or standard steel split specimen tube with accessories.

6.2 Test Specimen

Cylindrical test specimen of 50 mm height and 50 mm diameter produced on a standard rammer using steel specimen tube shall be used.

6.3 Procedure

Weigh sufficient quantity of tempered sand mixture to make, when rammed, a specimen of required height. Place the sand carefully in the specimen tube. After levelling the sand in the specimen tube, gently lower the ramming head into the specimen tube, until it is supported by the sand. Slowly raise the rammer weight by hand or by cam to the full height of the specimen and let it fall. Repeat twice, making a total of 3 rams to get the standard test specimen.

6.3.1 For sands which do not possess sufficient bond strength to permit handling, a circular drier plate shall be placed on top of a stripping post. After the specimen is stripped from the specimen tube , it shall be handled by lifting the drier plate.

6.3.2 For preparing specimens of low bond strength, ramming is done in a split specimen tube. The specimen, after it is rammed, is removed from the split specimen tube by opening the tube and allowing the specimen to rest on a drier plate.

SECTION 2 METHOD OF PHYSICAL TESTS FOR FOUNDRY MOULDING SANDS

7 DETERMINATION OF MOISTURE CONTENT

7.1 Direct Weight Method*

7.1.1 *Apparatus*

The apparatus shall consist of the following.

7.1.1.1 Balance with accuracy ± 0.1 g.

---

* *This method is applicable for all sand mixtures except those containing volatile material (other than water) or oxidisable materials such as core oils or both. For such sand mixture, calcium carbide method (see 7.2) shall be used.*

7.1.1.2 Desiccator

7.1.1.3 Drying oven (105°C - 110 °C)

7.1.1.4 Crucible

7.1.2 *Procedure*

Weigh accurately about 100 g of sample of sand in a crucible. Dry it in a uniformly heated oven between 105°C and 110°C for about one hour. Cool to room temperature and weigh. Repeat the process of drying and cooling till constant mass is attained.

7.1.3 *Calculation and reporting of results*

Calculate the moisture content from the following formula:

$$\text{Moisture content, per cent} = \frac{A}{B} \times 100$$

where
A = loss of mass of the sand sample in g on heating, and
B = mass in g of the sand sample taken.

7.1.3.1 Repeat the test on three separate samples and take the average of three test results as the moisture content of the sand.

7.2 Calcium Carbide method

7.2.1 *Apparatus*

Speedy moisture tester.

7.2.2 *Procedure*

Weigh accurately about 6 g of sample of sand and place it in the cap of the instrument. Take a measure of calcium carbide in the measuring scoop provided with the moisture tester and place in the shaker. Place the cap and the shaker in the horizontal position, adjust stirrup, fasten cap to shaker with set screw on stirrup and finally shake the contents. Read moisture content on dial gauge keeping the apparatus in a horizontal position.

7.2.3 *Reporting of results*

Make determinations on three separate samples and take the average of three results as the moisture content of the sand mixture.

NOTE

The sand mixture and calcium carbide should not come in contact with each other until the cap of the moisture tester is securely in place.

7.3 Control methods

For control tests, moisture in foundry sands may be determined by direct weight method, calcium carbide method or by any other method (such as dielectric type moisture meters) which will duplicate the accuracy of results obtained by the direct weight method.

8 DETERMINATION OF CLAY CONTENT

8.1 Reagent

8.1.1 *Sodium hydroxide solution*

Dissolve 30 g of sodium hydroxide in distilled water and dilute to a total volume of one litre.

8.2 Apparatus

An electric rapid agitator equipped with vertical baffles or a rotating sand washer shall be used.

8.3 Procedure

8.3.1 *High silica sand and natural moulding sand*

Take a 50 g representative sand sample. Spread it over a large area in thin layer and dry it for one hour at 105°C to 110°C so that all moisture is expelled.

Weigh the dried sample and place it in an electric rapid agitator equipped with vertical baffles or a rotating sand washer.

Add 475 ml of distilled water (pH 7.0 deionized or demineralized water) and 25 ml of sodium hydroxide solution at room temperature. Stir for five minutes. (If a rotating washer is used, place the cover on the jar, and the jar in a machine making about 60rev/min in such a manner as to allow the jar to be opened at each revolution. Operate the machine for one hour. Then remove the jar from the machine, unseal the cover and wash the adhering sand into the jar.) Wash sand from the stirrer into the jar and fill the jar with distilled water to a height of 150 mm above the bottom of the jar and in such a manner, that the contents are well stirred.

Allow to settle for 10 minutes and then siphon off the water to a depth of exactly 125 mm below the level to wh ch it had been filled, leaving a minimum depth of 25 mm of water in the bottom of the jar. Add distilled water, again filling the jar to the 150 mm height, stirring the sediment at the bottom. After settling for the second time for 10 minutes, again siphon off 125 mm of the water. Add water again filling to 150 mm height, stirring the sediment at the bottom. After settling exactly for 5 minutes, siphon off 125 mm of the water.

Repeat the process of five minutes standing and siphoning until the water is clear to a depth of 125 mm at the end of five minute period. By this method, the material which fails to settle at a rate of 25 mm per minute is removed. This is standard clay grade matter and includes all grains of 20 microns or less in diameter. Dry and weigh the remaining grains.

NOTE

Certain varieties of sand may require longer agitation to liberate properly the clay from the sand grains. Incomplete clay removal may be checked microscopically.

8.3.2 *Synthetic Sand Mixture*

The procedure in accordance with 8.3.1 shall be slightly changed for sand mixtures containing coal dust, coal residues, and binder residues. As given in 8.3.1, 50g of foundry sand is washed after drying. In the course of washing operation a part of the coal dust and similar substances are removed, the remiander being part of the sand portion. The washed sand portion is heated in a porcelain crucible to 750°C for burning the coal and the coal-free sand is weighed. The heating loss, equal to the total coal content, is determined by heating to 750°C and weighing a separate sample of unwashed, dried foundry sand. The heating time should be sufficient for complete combustion of the coal contained in the sand.

8.3.2.1 If cereal binders (especially dextrin) are present in the sand, a preliminary wash shall be made without adding sodium hydroxide to the distilled water. After stirring and allowing the sand to settle for 10 minutes, siphon off the water. Then proceed as described under 8.3.1.

8.3.2.2 A sand mixture containing cement cannot be washed free of cement by the method given under 8.3.1. The cement shall be removed from the sand grains by adding 25 ml of dilute hydrochloric acid (1 : 1 by volume) instead of sodium hydroxide, taking suitable precautions against acid attacking the agitating apparatus.

8.4 Calculation and reporting of results

8.4.1 Calculate the clay content of high silica sand and natural moulding sand from the following formula:

$$\text{Clay content, percent} = \frac{W_1 - W_2}{W_2} \times 100$$

$$\text{Sand portion, percent} = \frac{W_2}{W_1} \times 100$$

where

W_1 mass in g of the dried sand sample taken for the test, and

W_2 mass in g of the dried sand portion (free from clay).

8.4.2 Clay content of synthetic sand mixture shall be the difference between the true sand portion (washed and heated sample) plus coal portion (of unwashed and heated sample), and the total quantity of unwashed dried sand.

8.4.3 *Reporting of results*
Take the difference between the mass of the dried grains and that of the original 50 g sample as clay content.

9 DETERMINATION OF GRAIN FINENESS

9.1 Apparatus

A set of Sri Lanka Standards sieves (See **CS 124**)

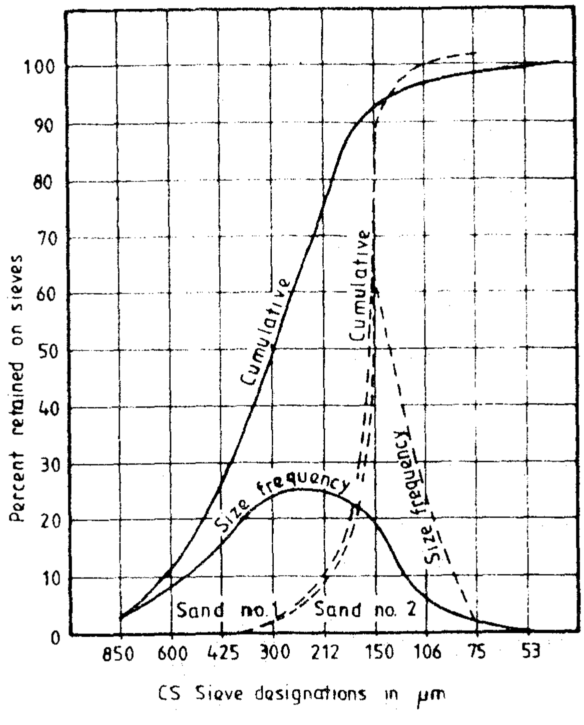
9.2 Procedure

Sieve 50 g of representative sample through 11 sieves (3.35 mm, 1.70 mm, 850 m, 600 m, 425 m, 300 m, 212 m, 150 m, 106 m, 75 m and 53 m Sri Lanka standard sieves) starting with the coarse sieve. Sifting time shall be atleast 15 minutes. Weigh out the sand retained on each sieve and the pan material Individually and put down as per cent of the dried unwashed sand.

9.3 Evaluation of fineness of sand

9.3.1 *Size frequency curve*

The size frequency curve shall be obtained by plotting the per cent of sand retained on each sieve (see Fig.1)



Note - Values along abscissa are plotted on log scale

Figure 1 - Curves constructed from sieve analysis of two foundry sands to show comparison of size frequency and cumulative curves

9.3.2 *Cumulative Curve*

The cumulative curve points shall indicate the percentage of particles larger than the sieve size represented by that point (see Fig.2). The cumulative curve is always smooth, whereas size frequency curve may not always be a broken line connecting the different sieve points. If a sand is taken on specification, two cumulative curves may be drawn showing the limiting values for each sieve. Then, if the curve of the sand being tested falls between these two curves it shall be satisfactory. Finally,data for slit and clay may be plotted as a part of the same graph. Sieves that retain little material may be eliminated or additional ones may be added without distorting the curve. If there are faulty sieves these shall be indicated by a break at the same point in the curve when different samples of the same sand are sieved.

9.3.3 *Sorting Coefficient*

An index to the sorting or distribution of the grains in a sand sample shall be obtained from the sorting coefficient, S_0 defined by the following formula :

$$S_0 = \frac{Q1}{Q2}$$

where Q1 is the size in m where the cumulative curve for a sand crosses the 25 percent retained line and Q2 is the size in m where the curve crosses 75 percent retained. Sorting coefficient is a rapid method of indicating the slope of the curve.

This is also a measure of the distribution.

The range of distribution numbers shall be from 1.0 for particles of uniform size, such as ball bearings to a maximum of about 10.0. Washed and graded sands shall range from 1.14 to 1.40 while naturally bonded sands are usually between 1.40 and 2.50.

9.4 **Calculation of fineness number**

Express the mass in grams of various sizes according to the procedure given under 9.2 as percentage of the original 50 g sample. Multiply them by the multipliers as given in Table 1. Add the products and divide the total by the sum of the percentages of sand grains. The result shall be the grain fineness number.

TABLE 1 - **Multiplier for grain fineness number**

CS SIEVE (1)	MULTIPLIER (2)
3.35 - mm	3
1.70 - mm	5
850 - m	10
600 - m	20
425 - m	30
300 - m	40
212 - m	50
150 - m	70
106 - m	100
75 - m	140
53 - m	200
Pan	300

10 DETERMINATION OF GRAIN SHAPE

10.1 Apparatus

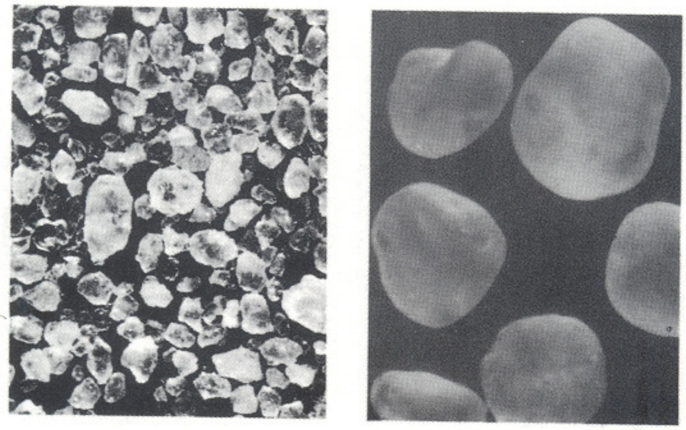
A low power stereoscopic microscope working with reflected light and giving magnifications of 30 x to 60 x.

10.2 Procedure

The grain shape shall be determined by the microscopic examination of a small portions of the grain size fractions from all the sieves and the pan at magnifications of 30 x to 60 x.

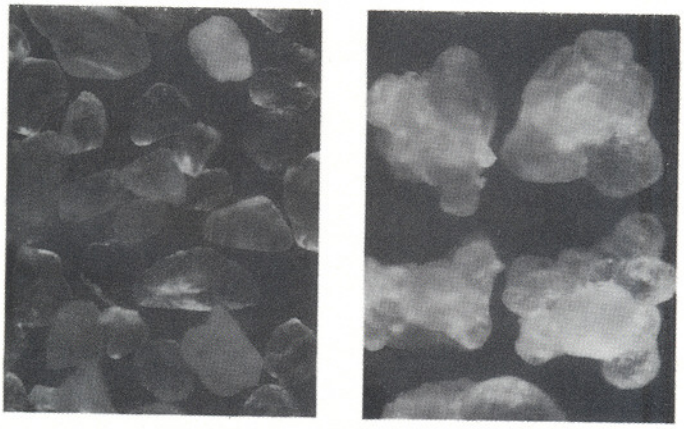
10.3 Reporting of results

The grain shapes to be distinguished are rounded, subangular, angular and splintered as shown in Fig. 2. Identification for grain shape shall be based on the predominant grain shape of the largest fraction (by mass) of sand.



Original Magnification 20X
Angular Sand Grains

Original Magnification 20X
Rounded Sand Grains



Original Magnification 20X
Sub-angular Sand Grains

Original Magnification 40X
Compound Sand Grains

Figure 2 - Sand grains

- Blank Page -

11 DETERMINATION OF PERMEABILITY

11.1 Determination of Base Permeability

11.1.1 *Apparatus*

Apparatus shall consist of the following:

11.1.1.1 Standard permeability meter.

11.1.1.2 Stop-watch.

11.1.1.3 Standard sand rammer

11.1.2 *Procedure*

Wash the sample for its clay content in accordance with the method given under 8.3 and dry the sand grains thoroughly at 105°C to 110°C.

Place a base permeability screen, with sides of the cup upward, in the bottom of the standard specimen container.

Place a sufficient quantity of dried sand in the specimen container to produce the standard sand test specimen.

Place the second base permeability screen, with sides of the cup downward, on top of the sand in the specimen container.

Ram the specimen in accordance with the method given in 6.3 but do not remove the specimen from the container.

Place the specimen container with the specimen in the mercury seal of the permeability apparatus.

Find out the time required for exactly 2000 ml of air to pass through the specimen. After the pressure has become steady, read the pressure on the pressure indicator and record in Pa.

11.1.3 *Calculation and reporting of results*

Calculate the base permeability number (P) of the sand from the following formula :

$$P = 98.1 \times \frac{v \times h}{p \times a \times t}$$

where

v = volume of air in ml passed through the specimen,
h = height of the test specimen in cm,
p = pressure of the air in Pa
a = cross-sectional area of the test specimen in cm^2 and
t = time in minutes.

11.1.3.1 Test three specimens individually. The base permeability shall be the average of three tests. If the test result of one of the test specimens varies more than 10 per cent from the average of three, this result shall be discarded and another specimen tested.

11.2 Determination of Green Permeability

11.2.1 *Apparatus*

Same as listed in 11.1.1.

11.2.2 *Test Specimen*

The standard test specimen specified under 6 shall be used.

11.2.3 *Procedure*

Ram the standard test specimen in a specimen container and follow the procedure as given in 11.1.2.

11.2.4 *Calculation and reporting of results*

Same as described in 11.1.3.

11.3 Determination of Dry Permeability

11.3.1 *Apparatus*

In addition to the apparatus described in 11.1.1 the following shall be used.

11.3.1.1 Special type of split specimen container used for ramming test specimens (see 6.3.2).

11.3.1.2 Standard drier

11.3.1.3 Special permeability machine attachment for the determination of dry permeability.

11.3.2 *Test Specimen*

The standard test specimen specified under 6 shall be used after drying at 105°C to 110°C in the drier for a period of 2 hours and cooling to room temperature in a desiccator.

11.3.3 *Procedure*

Using the split specimen container to hold the dried specimen, determine the dry permeability as in 11.1.2.

11.3.4 *Calculation and reporting of results*

Same as described in 11.1.3

12 DETERMINATION OF COMPRESSION STRENGTH

12.1 Determination of Green Compression Strength

12.1.1 *Apparatus*

Dead weight type of universal sand strength testing machine or spring type of sand strength testing machine.

12.1.2 *Test Specimen*

The standard test specimen specified in 6 shall be used.

12.1.3 *Procedure*

Ram a standard test specimen and strip it from the specimen container.

Place the test specimen in the compression machine in such a manner that the top of the specimen as rammed in the specimen container rests against the upper head of the machine.
Apply a load along the axis of the specimen at a rate of 21 ± 4 kPa per minute until the specimen breaks.

Record the load at rupture.

12.1.4 *Calculation and reporting of results*

Calculate the green compression strength from the following formula :

$$\text{Green compression strength} = \frac{F}{A} \times 10^3 \text{kPa}$$

where

F = load at rupture in N, and
A = cross-sectional area of the test specimen in mm^2.

12.1.4.1 Test three specimens individually. The compressive strength shall be the average of three tests. If the test result of one of the specimens varies by more than 10 per cent, from the average of the three, this result shall be discarded and another specimen tested.

12.2 Determination of Dry and Baked Compression Strength

12.2.1 *Apparatus*

Same as specified in 12.1.1

12.2.2 *Test Specimen*

The standard test specimen specified in 6 shall be used.

12.2.2.1 Drying

When the test is applied to sands for use in green sand moulds, the specimen shall be dried on a flat, rigid plate in a ventilated oven at a temperature not less than 105°C not more than 110°C for 2 hours or until dry and allowed to cool to room temperature in a desiccator. Test the specimen after it has reached the room temperature.

12.2.2.2 Baking

When the test is applied to sands used for dry sand moulding or to other mixtures which would normally be baked at a temperature higher than 110 C, a baking temperature and time which is suitable for that particular mixture should be used. After baking allow the specimen to cool in a desicator to room temperature.

12.2.3 *Procedure*

The standard test specimen after removal from the specimen container shall be dried or baked and cooled as specified in 12.2.2.1, 12.2.2.2. The specimen should be placed in the apparatus with the same side against the compression head which was uppermost in the specimen container during ramming.

Apply a load along the axis of the specimen at a rate of 100 ± 15 kPa per minute, until the specimen breaks. Record the load at rupture.

12.2.4 *Calculation*

Calculate the dry or baked compression strength as given in 12.1.4.

13 DETERMINATION OF SHEAR STRENGTH

13.1 Determination of Green Shear Strength

13.1.1 *Apparatus*

Universal standard sand testing machine with shear strength attachment.

13.1.2 *Test Specimen*

The standard test specimen specified in 6 shall be used.

13.1.3 *Procedure*

Ram a standard test specimen and strip from the specimen container.

Place the specimen between the shear heads of the machine in such a way that the load is applied along a line through its axis.

Apply a uniform load to the diametrically opposite halves of the two plain surfaces of the specimen at the rate of 17 ± 4 kPa per minute.

Record the breaking load in kgf and calculate the shear strength in kPa by dividing the breaking load by area of cross section of the specimen.

13.1.3.1 Test three specimens individually. The sheer strength shall be the average of three tests. If the test result of one of the specimens varied more than 10 per cent, from the average of the three, this result shall be discarded and another specimen tested.

13.2 Determination of Dry Shear Strength

The method given in 13.1 shall be employed for the determination of dry shear strength, except that the test specimen shall be dried at 105°C to 110°C for 2 hours or until dried, and allowed to cool in a desiccator to room temperature before testing.

14 DETERMINATION OF BULK DENSITY

14.1 Determination of Bulk Density Before Compression

14.1.1 *Apparatus*

Balance with accuracy ± 1g.

14.1.2 *Procedure*

Take 500 g of tempered sand mixture as prepared under 5 and allow it to fall in a one-litre measuring cylinder through a perforated disc rotating slowly at the 1000 ml mark. After the whole sand has dropped into the measuring flask, even out the sand surface by slightly pressing with the perforated disc.

14.1.3 *Calculation and reporting of results*

The ratio of the mass of the sand to the volume occupied by it will represent the bulk density before compression in g/ml .

14.2 Determination of Bulk Density after compression

14.2.1 *Apparatus*

Standard rammer and physical balance.

14.2.2 *Test Specimen*

The standard test specimen specified in 6 shall be used.

14.2.3 *Procedure*

Ram a standard test specimen as given in 6.3. Weigh it in a balance and also calculate its volume from its dimensions.

14.2.4 *Calculation and reporting of results*

The ratio of the mass of the specimen to the volume will give the bulk density after compression in g/ml

15 DETERMINATION OF GREEN MOULD SURFACE HARDNESS

15.1 Apparatus

Standard mould surface hardness tester.

15.2 Test Specimen

The standard test specimen specified in 6 shall be used.

15.3 Procedure

Bring the unloaded plunger of the tester in contact with the mould specimen surface. Apply the load to the plunger and read the hardness number on the graduated dial of the testing apparatus.

NOTE

The test is performed on standard test specimen prepared as given in 6 or on the mould itself. The test should be performed immediately after the specimen is stripped from the tube or the pattern is withdrawn from the mould.

15.4 Reporting of results

The hardness number read in the graduated dial of the testing apparatus shall be the green mould surface hardness.

16 DETERMINATION OF FLOWABILITY

16.1 Apparatus

Standard sand rammer together with the standard flowabilty meter.

16.2 Test Specimen

The standard test specimen specified in 6 shall be used.

16.3 Procedure

Read the per cent flowability on the dial of the flowability meter after the fifth drop of the ramming weight. The stem of the flowability meter rests against the top of the plunger of the rammer and registers the movement of the rammer plunger between the fourth and fifth drops as percentage flowability . Test three specimens individually.

16.4 Reporting of results

The flowability number shall be the average of three tests. If the test result of one of the specimens varies more than 10 per cent from the average of three, this result shall be discarded and another specimen tested.

17 DETERMINATION OF SHATTER INDEX

17.1 Apparatus

17.1.1 *CS sieve 12 mm*

17.1.2 *Standard sand rammer*

17.2 Test specimen

The standard test specimen specified in 6 shall be used.

17.3 Procedure

Ram a standard test specimen by 10 blows in accordance with the method given in 6.3 and allow it to fall from a height of 1 830 mm. Collect the portion of the sand retained on 12 mm CS Sieve.

17.4 Calculation and Reporting of results

Calculate the percentage mass retained in the sieve.
The per cent mass retained shall be the shatter index.

18 DETERMINATION OF SINTERING POINT OF FOUNDRY SAND MIXTURES

18.1 Apparatus

18.1.1 Porcelain combustion boats of 75 to 90 mm length and 10 to 15 mm width.

18.1.2 Electric furnace with a testing temperature of at least 1500° C.

18.2 Procedure

Loosely fill the sand sample in the combustion boat and place the boat in the hot zone of the electric furnance. When temperature has reached 1 000°C keep the temperature constant for at least 3 minutes.

Take out the boat from the furnance, cool and observe whether the sintering of the sand grain has started. If not sintered, replace the combustion boat in the furnace and continue the test with temperature increments of 50 °C till sintering occurs.

Keep the combustion boat at each particular temperature for at least 3 minutes. After cooling, examine the sand sample for sintering by scraping or visual examination with a magnifier or microscope.

18.3 Recording of Results

The temperature at which the sintering occurs shall be recorded.

SECTION 3 METHODS OF PHYSICAL TESTS FOR FOUNDRY CORE SANDS

19 DETERMINATION OF MOISTURE CONTENT

19.1 **Direct weight method** - Same as given in 7.1

19.2 **Calcium Carbide method** - Same as given in 7.2

20. DETERMINATION OF CLAY CONTENT

20.1 Same as given in 8.

21 DETERMINATION OF GRAIN FINENESS

21.1 Same as given in 9

22 DETERMINATION OF GRAIN SHAPE

22.1 Same as given in 10

23 DETERMINATION OF PERMEABILITY

23.1 Determination of Base Permeability

Same as given in 11.1

23.2 Determination of Green Permeability

Same as given in 11.2.

23.3 Determination of Dry Permeability

Same as given in 11.3.

23.4 Determination of Baked Permeability

23.4.1 *Apparatus*

The apparatus specified in 11.3.1 and a core baking oven of the following specification :

The oven shall be capable of giving uniform temperature up to 320 ° C and shall be equipped with automatic regulator to maintain an even and uniform oven temperature with a variation not greater than 5 degree over the entire temperature range.

Openings shall be provided through which baked cores may be removed at different intervals, when testing for baking time, without causing a drop in temperature of more than 5 degree. The input of heat shall be such that, after putting in the charge, the oven shall return to the desired baking temperature in 20 minutes.

23.4.2 *Test Specimen*

Same as specified in 11.3.2.

23.4.3 *Procedure*

Same as specified in 11.3.3

NOTE

The permeability needed for a given core depends on the amount of gas forming materials in the sand mixture used.

23.4.4 *Calculation and reporting of results*

Same as described in 11.3.4.

24 DETERMINATION OF STRENGTH

24.1 **Green Compression Strength**

Same as given in 12.1

24.2 **Baked Compression Strength**

Same as given in 12.2

24.3 **Determination** of **Baked Tensile Strength**

24.3.1 *Apparatus*

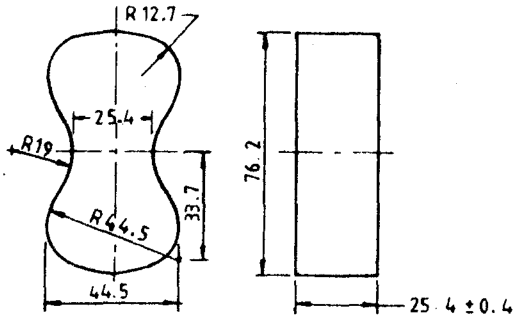
24.3.1.1 Universal standard sand testing machine on with tensile strength attachment.

24.3.1.2 Standard sand rammer with the equipment for making briquette type of special test specimens.

24.3.1.3 Standard baking oven for core

24.3.2 *Test Specimens*

24.3.2.1 The test specimens shall be of shape and dimensions given in fig. 3 or shall have a rupture section of 22.36 mm x 22.36 mm that is 5 cm^2.



Dimensions in millimetres

Figure 3 - **Test Specimens for Testing Tensile strength of core sand mixture**

24.3.2.2 A two-part metal core box, provided with a loading hopper, ramming plate, and rammer head which may be attached to a standard rammer used for making test specimen.

24.3.2.3 Baking of test specimens - Bake a number of test specimens under the following conditions :

a) at 180°C for 3/4 h, 1h, 1 1/2 h and 2 1/2 h
b) at 220°C for 3/4 h, 1h , 1 1/2 h ,2 h and 2 1/2 h ,and
c) at 250°C for 3/4 h, 1h , 1 1/2 h ,2 h and 2 1/2 h.

24.3.2.4 After baking allow the core specimens to cool, to room temperature in a desiccator. Any test specimens showing an imperfection shall be rejected. Caliper each test specimen to check dimensions. Reject the specimens if any dimension is not within ± 5 percent. The specimen shall be tested as soon as possible after having taken out from the desiccator.

24.3.3 *Procedure*
Fit the grips for pulling tensile test specimens in the universal testing machine.

Place the specimen into the grip of the machine in such a way that it is gripped uniformly along with the lateral surfaces and so that the load is applied along a line through its axis. Apply load at the rate of 40 ± 5 kpa per minute.

Record the breaking load in N.

24.3.4 *Calculation and reporting of results*
Calculate the tensile strength in kPa, by dividing the breaking load with area of rupture section. An average of the three tensile tests at each baking time and temperature (see 24.3.2.3) shall be taken. If the test result of one of the three varies more than 10 percent from the average of three, this result shall be discarded and another specimen tested. From these results the optimum baking temperature and time to get the maximum tensile strength shall be deduced.

24.4 Humidity Test and Determination of the Loss of baked strength Under Humid Conditions

24.4.1 *Apparatus*

Same as specified in 24.3.1

24.4.1.1 Humidity chamber

See Fig. 4.

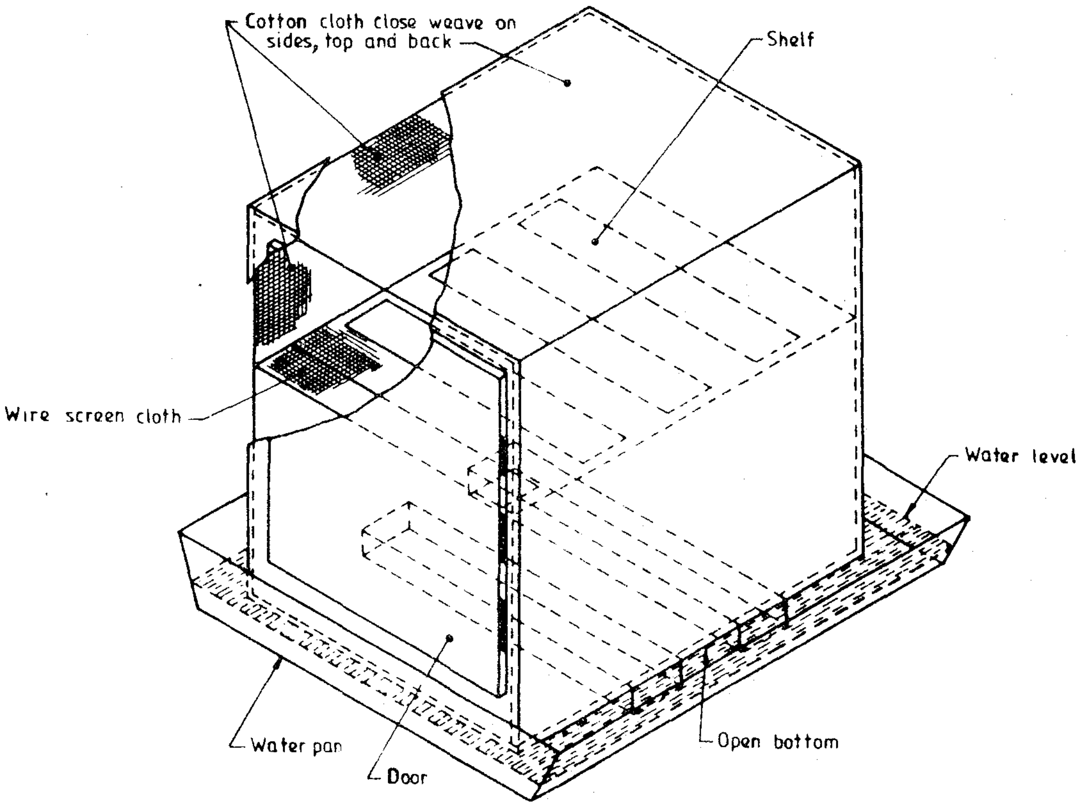


Figure 4 - **Humidity Test Chamber (Shelf area 500 x 375 mm approx.)**

24.4.2 *Test Specimens*

The test specimens specified in 24.3.2 shall be used.

24.4.3 *Procedure*

Bake a sufficient number of standard tensile test specimens at the optimum temperature for the optimum period of time (see 24.3.2.1).

Cool them to room temperature in a desiccator. Test three samples to give average tensile strength.

Place the remaining test specimens in the humidity chamber, and test for tensile strength, three at a time after 1h ,2h,4h and 8h hours in humid atmosphere.

24.4.4 *Calculation and reporting of results*

Find the average loss in tensile strength, and plot as a percentage of the original tensile strength of the specimen with the time interval.

24.5 Determination of baked transverse strength

24.5.1 *Apparatus*

24.5.1.1 Universal testing machine with the attachment for transverse test.

24.5.1.2 Standard sand rammer

24.5.1.3 Special core box assembly with a drier plate and hopper and a rammer head to be attached with the standard rammer.

24.5.1.4 Standard baking oven

24.5.2 *Test specimens*

24.5.2.1 The test bar shall have the dimensions 25.4 mm x 25.4mm x 203.2 mm or having a square section of 22.36 mm x 22.36 mm, that is, a section of 5 cm^2 and a length of about 170 mm.

24.5.2.2 Ram three test bars and strip them from the core box on a core plate. Bake the test specimens at the optimum temperature for the optimum period. (see 24.3.3.1)

24.5.3 *Procedure*

Place the test specimens on the supports of the teting machine in the same relative position in which it was baked. apply a load midway between supports at the rate of 80 ± 12 kPa per minute. Record the breaking load in N .

$$\text{Transverse strength} = \frac{3\ Wl}{2\ bd^2} \times 10^{3}\ \text{kPa}$$

where

W = total load in N at which the failure occurs,
l = distance between supports in mm,
b = width of the test specimen in mm, and
d = thickness of the test specimen in mm.

24.5.3.2 Calculation and reporting of results

An average of the results of three tests conducted on three individual test specimens shall be reported as the transverse strength. If the test result of one of the test specimens varies, more than 10 percent from the average of the three, this result shall be discarded and another specimen tested.

25 DETERMINATION OF BULK DENSITY

Same as given in 14

26 DETERMINATION OF BAKED SCRATCH HARDNESS

26.1 **Apparatus**

Standard baked core hardness tester.

26.2 **Test specimens**

The hardness shall be tested on the tensile or transverse test specimens baked at optimum temperature for the optimum period (see 24.3.2 and 24.3.2.3).

26.3 **Procedure**

Hold the hardness tester in the right hand and press it against the surface of the test specimen. This will give an indentation hardness value. slowly pull the tester across the surface to be tested, making sure that the knife-edge is parallel to the long edge of the tester. the hardness of the surfaces will be indicated on the dial. Perform the test at three different locations over the specimen and record the readings.

26.4 Reporting of results

The average of three readings recorded shall be reported as hardness number.

27 DETERMINATION OF GAS GENERATED IN A CORE DURING BAKING

The amount of gas generated within a core during baking, pouring and solidification of the metal is of considerable importance of foundry men. Since ample 'venting' of cores and moulds has to be provided for removal of this gas, both the volume of gas and the rate at which it is evolved are important.

27.1 Apparatus

Core gas determinator with accessories

27.2 Test sample

Broken halves of baked tensile or transverse test specimens shall be used. Dry all specimen material to constant weight at 105°C to 110°C and cool in a desiccator. Rub two sections of the core specimens together over a suitable piece of paper in order to obtain a cross-sectional representative sample, alternatively core sand may be pulverized to pass entirely through 1.70 mm CS Sieve (see **CS 124**)

27.3 Procedure

Weigh accurately about 2 to 3 g of the test sample in tared combustion boat or suitable crucible which has been pre-heated and cooled in a desiccator. Keep it in a desiccator between the time of weighing and testing. Place the sample in the combustion tube and heat it in an atmosphere of carbon dioxide or nitrogen (non-oxidizing) at 1 000°C and collect the gas evolved. Record the volume of the gas collected in the burette after every 30 seconds. Record also the final volume of the gas evolved. This may require as much as 10 to 12 minutes.

27.4 Calculation and reporting of results

Calculate the volume in millilitres of gas evolved per gram of the sample from the following formula:

$$\text{Gas in ml/g} = \frac{\text{Total corrected gas volume in ml}}{\text{Sample mass in g}}$$

If it is desired to reduce the volume of gas to NTP (normal temperature and pressure), correction shall be made for mean barometric pressure and temperature.

27.4.1 For the rate of gas evolution, divide the gas volume by the sample mass to obtain the reading in ml/g, for each time interval. Plot these values against time interval to indicate the rate of gas evolution.

28 DETERMINATION OF SINTERING POINT

Same as given in 18.

****

SLS CERTIFICATION MARK

The Sri Lanka Standards Institution is the owner of the registered certification mark shown below. Beneath the mark, the number of the Sri Lanka Standard relevant to the product is indicated. This mark may be used only by those who have obtained permits under the SLS certification marks scheme. The presence of this mark on or in relation to a product conveys the assurance that they have been produced to comply with the requirements of the relevant Sri Lanka Standard under a well designed system of quality control inspection and testing operated by the manufacturer and supervised by the SLSI *which includes surveillance inspection of the factory, testing of both factory and market samples.*

Further particulars of the terms and conditions of the permit may be obtained from the Sri *Lanka Standards Institution, 17, Victoria Place, Elvitigala Mawatha, Colombo 08.*

Printed at SLSI (Printing Unit)

SRI LANKA STANDARDS INSTITUTION

The Sri Lanka Standards Institution (SLSI) is the National Standards Organization of Sri Lanka established under the Sri Lanka Standards Institution Act No. 6 of 1984 which repealed and replaced the Bureau of Ceylon Standards Act No. 38 of 1964. The Institution functions under the Ministry of Science & Technology.

The principal objects of the Institution as set out in the Act are to prepare standards and promote their adoption, to provide facilities for examination and testing of products, to operate a Certification Marks Scheme, to certify the quality of products meant for local consumption or exports and to promote standardization and quality control by educational, consultancy and research activity.

The Institution is financed by Government grants, and by the income from the sale of its publications and other services offered for Industry and Business Sector. Financial and administrative control is vested in a Council appointed in accordance with the provisions of the Act.

The development and formulation of National Standards is carried out by Technical Experts and representatives of other interest groups, assisted by the permanent officers of the Institution. These Technical Committees are appointed under the purview of the Sectoral Committees which in turn are appointed by the Council. The Sectoral Committees give the final Technical approval for the Draft National Standards prior to the approval by the Council of the SLSI.

All members of the Technical and Sectoral Committees render their services in an honorary capacity. In this process the Institution endeavours to ensure adequate representation of all view points.

In the International field the Institution represents Sri Lanka in the International Organization for Standardization (ISO), and participates in such fields of standardization as are of special interest to Sri Lanka.

Printed at the Sri Lanka Standards Institution, 17, Victoria Place, Elvitigala Mawatha,
Colombo 08.