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Stabilized soil blocks — Specification

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Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

DRS 510 was prepared by Technical Committee RSB/TC 9, *Civil engineering and building materials*.

In the preparation of this standard, reference was made to the following standard:

KS 1070:1993, *Specification for stabilized soil blocks*

The assistance derived from the above source is hereby acknowledged with thanks.

Committee membership

The following organizations were represented on the Technical Committee on *Civil engineering and building materials* (RSB/TC 9) in the preparation of this standard.

A+Construction Group Ltd

Africeramics Ltd

Consultants Engineers Group (CEG) Ltd

D&D Resources Ltd

Dutureheza Ltd

Enabel Rwanda

Greenpack Africa Ltd

Integrated Polytechnic Regional Centre (IPRC) - Musanze

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Introduction

Soil is perhaps the oldest and most abundant building material available to mankind. However, the use of soil as a conventional building material is limited in this country. With increasing need to house and ever growing population, the use of earth must be re-visited in view of its abundance and versatility.

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Stabilized soil blocks — Specification

1 Scope

This Draft Rwanda Standard specifies requirements, sampling and test methods for stabilized soil blocks using cement and/or lime, and fibre for use in general construction.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

RS EAS 18-1, *Cement — Part 1: Composition, specification and conformity criteria for common cements*

DRS 546, *Clay products for buildings — Vocabulary*

EAS 73, *Building limes (Quicklime and Hydrated Lime) — Specification*

RS ISO 10545-2, *Ceramic tiles — Part 2: Determination of dimensions and surface quality*

RS ISO 10545-4, *Ceramic tiles — Part 4: Determination of modulus of rupture and breaking strength*

RS 266, *Concrete building blocks — Specification*

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in DRS 546 and the following apply.

3.1

stabilized soil blocks

building blocks made by a mixture of soil with a portion of cement and/or lime, fibre, or sand as a stabilizer

3.2

nominal size

size of a co-ordinating space allocated to a masonry unit including allowances for joints and tolerance

Note 1 to entry: The nominal size corresponds to the work size plus a 1 cm for joint.

3.3

work size

size of a block specified for its manufacture to which its actual size should conform within the specified permissible deviations

3.4

compressive strength

force per unit area required to cause a set specimen to fail under compression

3.5

modulus of rupture

maximum load/unit area of cross section at breaking, under flexural loading conditions

4 Requirements

4.1 General requirements

4.2 Materials

4.2.1 Cement

The cement used for the manufacture of stabilized soil blocks shall conform to RS EAS 18-1.

4.2.2 Soils

The soils used for the manufacture of stabilized soil blocks shall be free of deleterious and organic materials.

4.2.3 Lime

The lime used for the manufacture of stabilized soil blocks shall conform to EAS 73.

4.2.4 Sand

The sand to be used for stabilizing the soils shall be either natural river sand, crushed stone sand or crushed gravel sand. It shall be free from any type of salt/chemical and organic matter.

4.2.5 Water

When the block is stabilized by cement, water shall be clean and free from heavy metals, salts and any other deleterious matter harmful to the cement reactions.

4.3 Manufacturing

Stabilized soil blocks shall be manufactured in a system that ensures consistency in quality. The system shall put in place measures to ensure the quality of raw materials, production and post-production management. The system shall be documented.

4.4 Freedom from defects

4.4.1 Blocks shall be of homogeneous colour and texture.

4.4.2 Blocks shall be free from cracks, pits, broken edges, honey comb and other defects that would interfere with the proper placing of blocks or impair the strength or performance of construction.

4.4.3 Blocks shall be reasonably free from surface flaws, laminations, crumbly and imperfect edges.

4.5 Shape, dimensions and tolerances

4.5.1 Dimensions

When measured in accordance with RS ISO 10545-2, the dimensions of stabilized soil block shall conform to Table 1.

Table1 — Dimensions of stabilized soil blocks

Length (mm)			Width (mm)		Height (mm)
Nominal size	Work size		Nominal size	Work size	
200	190		100	90	55
200	190		100	90	75
300	290		100	90	80
300	290		150	140	100
400	390		150	140	105
400	390		200	190	125

4.5.2 Tolerances

The maximum dimensional deviations for stabilized soil blocks measured in accordance with Annex A shall be as specified in Table 2.

Table 2 — Dimensional tolerances for stabilized soil blocks

Dimension	Maximum dimensional deviation, mm
Length	± 3
Width	± 2
Height	± 1
Surface smoothness sides	± 1
Compression surface	+3 - 1

5 Physical properties

5.1 Dry compressive strength

The dry compressive strength at 28 days when tested in accordance with RS 266, shall not be less than 2.5 N/mm².

5.2 Wet compressive strength

When stabilized soil blocks are tested in accordance with RS 266, the minimum average wet compressive strength at 28 days, shall not be less than 1.5 N/mm².

5.3 Modulus of rupture

The rupture strength when determined in accordance with RS ISO 10545-4, shall not be less than 0.5N/mm².

5.4 Water absorption

The water absorption of stabilized soil blocks when determined as described in RS ISO 10545-3, shall not exceed 22 % of the original mass.

5.5 Linear expansion on saturation

The linear expansion on saturation of the blocks, being the average of three specimens, when determined in accordance with the procedure described in Annex E, shall not exceed 0.10 %.

5.6 Density

The density of blocks when determined in accordance with Annex C, shall not be less than 1 600kg/m³.

5.7 Weathering

When subjected to the weathering test carried out in accordance with Annex D, the maximum loss of mass shall not exceed 3 %.

5.8 Shrinkage cracks

Shrinkage cracks shall not be more than 0.5 mm wide and shall not exceed in length 50 % of the block dimension to which they are parallel, where they are not parallel, their projected length shall be measured.

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Annex A (informative)

Common stabilized soil blocks and their dimensions in millimetres

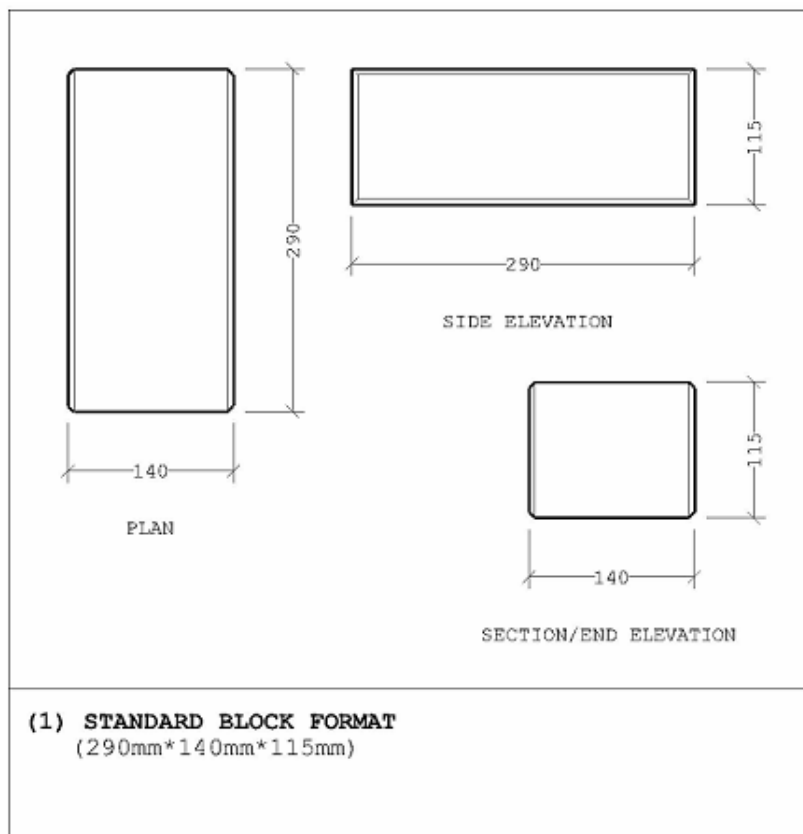


Figure A.1 — Standard block

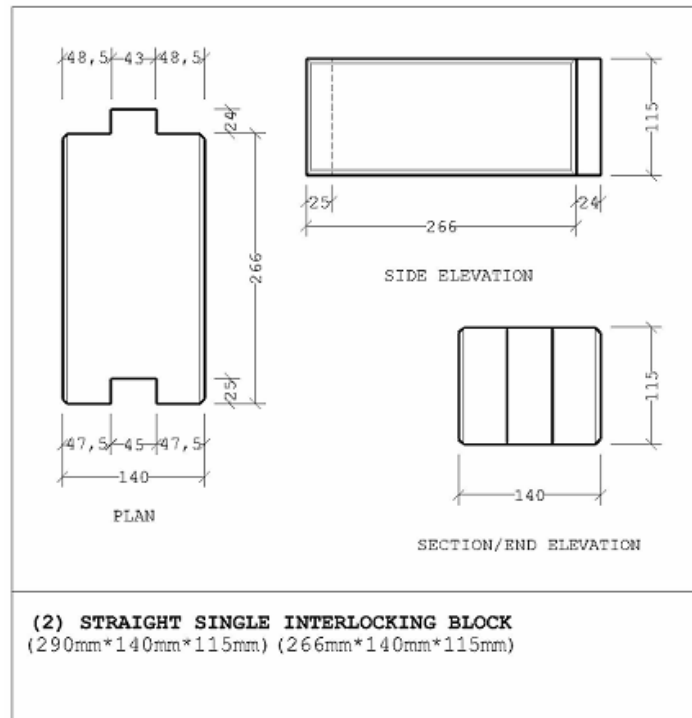


Figure A.2 — Straight single interlocking block

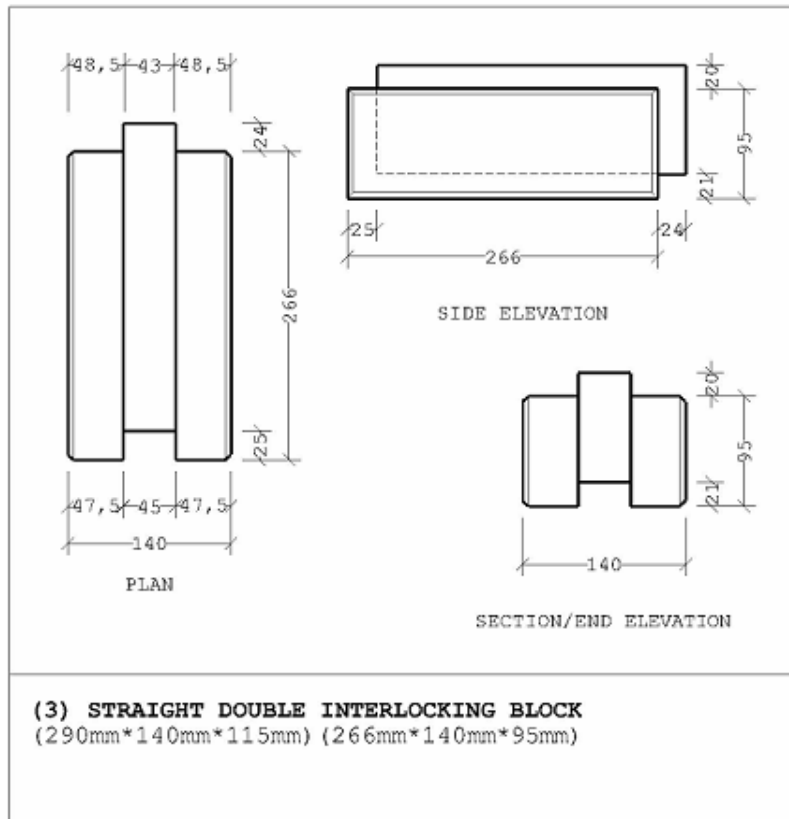


Figure A.3 — Straight double interlocking block

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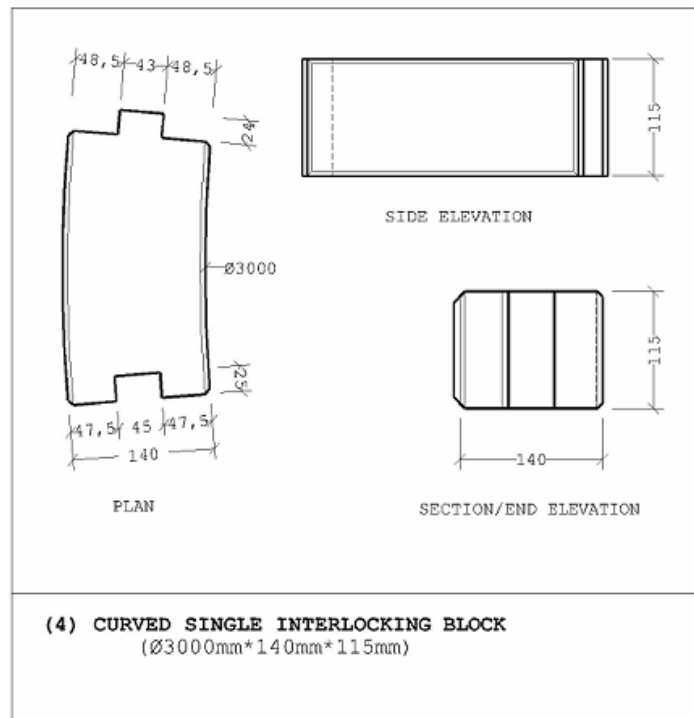


Figure A.4 — Curved single interlocking block

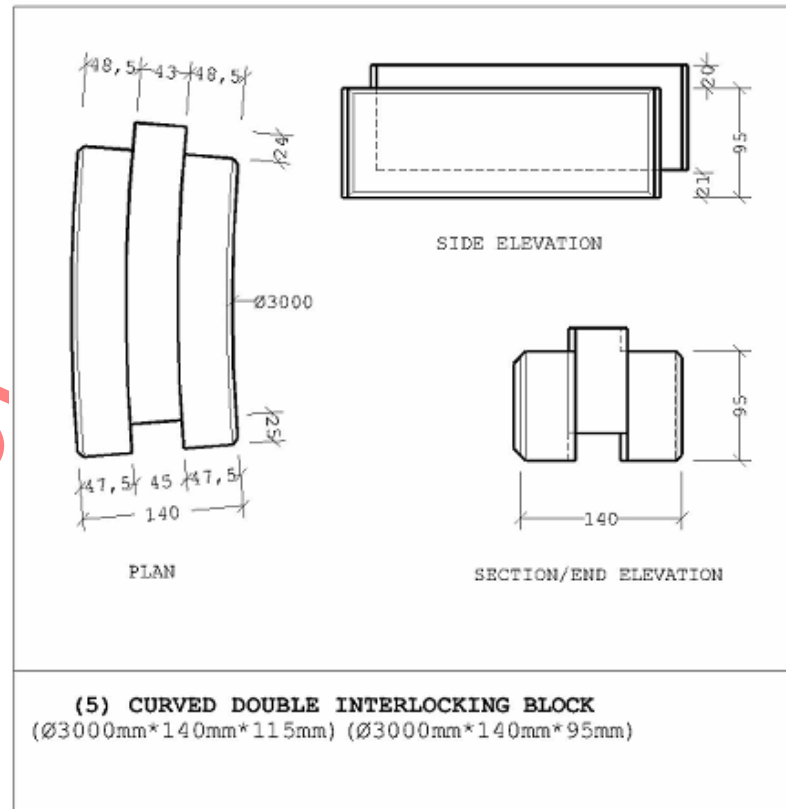


Figure A.5 — Curved double interlocking block

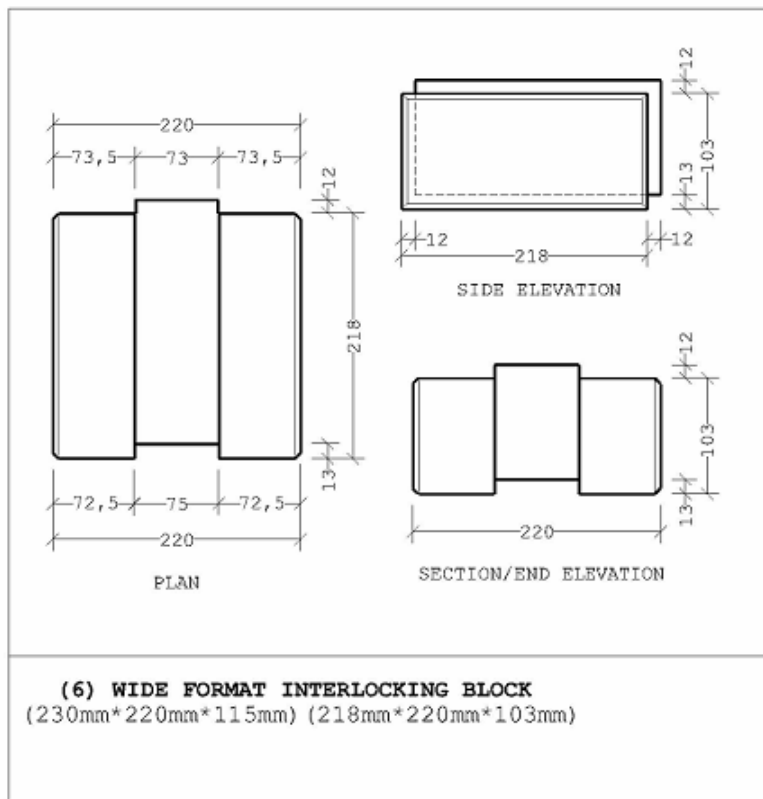


Figure A.6 — Wide format interlocking block

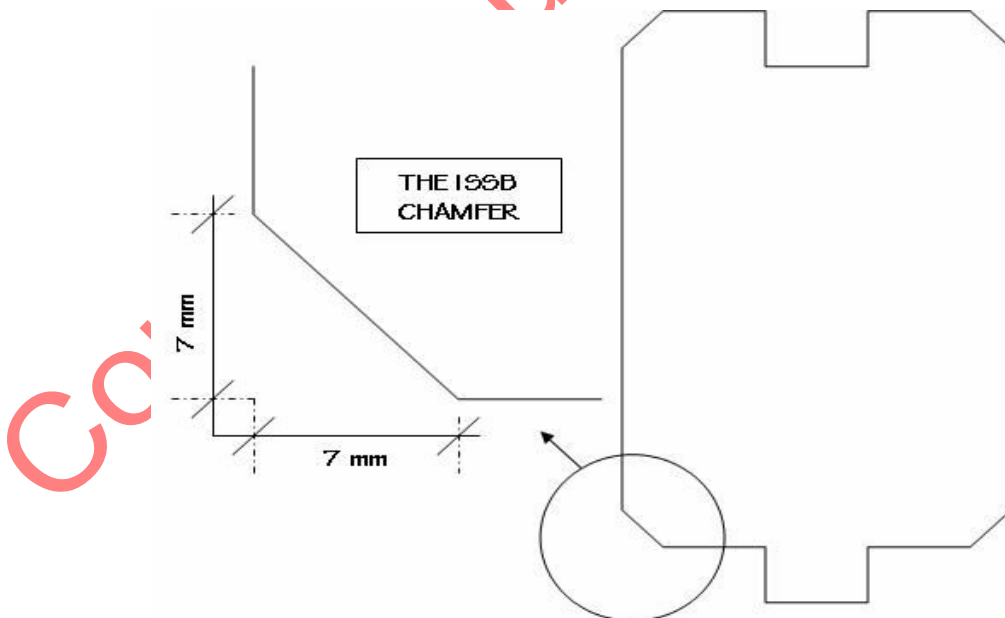


Figure A.7 — Chamfered edges dimension

Annex B (normative)

Determination of compressive strength

B.1 Test specimens

Ten whole blocks shall be selected at random from the sample after carrying out the dimensional checks. Five blocks shall be used for dry compressive strength and another five for wet compressive strength.

B.2 Principle

B.2.1 Dry compressive strength

A unit is placed in a compressive testing machine and subjected to increased compression until it fails. The compression strength is calculated from the maximum load.

B.2.2 Wet compressive strength

A unit is immersed in water for a specified period of time. The unit is then tested using the same principles as clause B.2.1.

B.3 Apparatus

B.3.1 Loading machine

A compression loading machine either hydraulic or screw type with adequate capacity and capable of applying the loads at rates specified in clause B.4.

The machine shall be fitted with two steel platens which shall be self-aligning.

The bearing faces of both platens should exceed the test specimen by not less than 15 mm length in length and breadth and shall not depart from a plane by more than 0.06 mm. Should the bearing faces of the platens be smaller than required, steel plates of adequate size may be placed centrally between them and the test specimen. Their thickness shall be equal to at least one-third of the greater difference in dimension in between the machine platen and the test specimen, when centrally placed but not less than 25 mm.

B.3.2 Measuring ruler

A ruler that can be read accurately to 1.0 mm over the dimensions of the units being tested.

B.3.3 Water bath

A water bath of sufficient size to hold the specimens without them touching each other and sufficient depth to ensure that the specimens will be completely immersed in water for the full duration of the test.

B.4 Dry compressive strength

B.4.1 Procedure

B.4.1.1 Measure and record the following dimensions as per RS ISO 10545-2, to the nearest millimetre:

- a) the width (B); and
- b) the length (L).

B.4.1.2 Clean and wipe the surfaces of the test specimen removing all loose debris. Clean the bearing surfaces of the platens on the testing machine, and any steel plates to be placed between the specimen and platen.

B.4.1.3 Place the specimen between two pieces of 3 mm thick plywood, the length and width of which shall exceed the corresponding dimensions of the specimen by less than 25 mm each plywood shall be used only once. The specimen shall be placed in the testing machine such that the centre of the bed face coincides with the loading axis of the machine.

B.4.1.4 Apply the load without shock and increase it continuously at a uniform rate of 150 kN/min until failure occurs.

B.4.1.5 Observe and record the maximum load (W_D) at failure.

B.5 Wet compressive strength

B.5.1 Procedure

- a) Measure and record the following dimensions to the nearest millimetre:
 - i) the width (B) of each specimen as described in clause A3; and
 - ii) the width (B) of each specimen as described in clause A3;
- b) the length (L) of each specimen as described in clause A3. (b) The specimen shall be immersed in water at 15 °C to 30 °C for 24 h;
- c) the specimen shall be removed from the water bath. They shall then be wiped clean with a piece of cloth;
- d) the procedure for the compression testing shall proceed as described in clause B.4.1 to clause B.4.1 (d); and

e) Observe and record the maximum load (WW) at failure.

B.6 Calculation of results

The compressive strength of each specimen (dry or wet) shall be calculated from the the following expressions:

$$C_D = \frac{W_D}{A} \text{ or } C_W = \frac{W_W}{A}$$

where

C_D = dry compressive strength in N/mm²;

C_W = wet compressive strength in N/mm²;

W_D = total load at which the dry specimen fails, in Newtons;

W_W = total load at which the wet specimen fails, in Newtons;

A = the smaller bed face area, in square millimetres.

Length (L) and width (B) taken for whichever of two bed faces produces the smaller area.

B.7 Reporting

Report the average of the compressive strength; either dry or wet of the five specimens.

Annex C (normative)

Determination of block density

C.1 Test specimens

Select at random three blocks from the sample for testing. Carry out the dimensional measurements as described in Annex RS ISO 10545-2, noting the average length, height and width of each block.

C.2 Apparatus

C.2.1 Drying oven

Thermostatically controlled drying oven capable of maintaining temperature at $105\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

C.2.2 Calculating of volume

Calculate the gross volume of the blocks to the nearest 250 mm^3 by multiplying the average thickness by the average length and height of the block.

C.3 Procedure

Dry the three specimen blocks for at least 24 h in a ventilated oven at $105 \pm 5\text{ }^{\circ}\text{C}$.

Cool the blocks to ambient temperature and weigh. Repeat these steps until the mass lost in one cycle does not exceed 0.05 kg.

C.4 Calculation of density

$$C_b = \frac{M}{V}$$

where

C_b block density (in kg/m^3);

M oven dry mass (in kg); and

V gross volume in blocks (in m^3).

C.5 Reporting

Report the density to the nearest 10 kg/m^3 .

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Annex D **(normative)**

Weathering test

D.1 Test specimens

Two whole blocks shall be selected from the sample of blocks obtained as described under Annex A, after carrying out the test for dimensional conformity. The blocks shall be designated “specimen A” and “specimen B”, respectively.

D.2 Apparatus

D.2.1 Balance

A balance or scale of a 20-kilogram capacity, sensitive to 50 g.

D.2.2 Drying ovens

Two thermostatically controlled drying ovens, one capable of maintaining temperature at 105 ± 5 °C and the other capable of maintaining temperature at 70 ± 5 °C.

D.2.3 Water bath

A suitable tank for submerging specimens in water at room temperature.

D.2.4 Wire scratch brush

A brush made of 50 mm x 1.6 mm flat with 0.4 mm wire bristles assembled in 50 longitudinal rows and 10 transverse rows of bristles on 200 mm x 60 mm hardwood block.

D.3 Procedure

D.3.1 Oven dry specimen A at 105 ± 5 °C for at least 12 h or to a constant mass. From this weight, calculate the oven – dry weight (W_1) of specimen A. Carry out further operations on specimen B only.

D.3.2 Submerge specimen B in water at room temperature for 6 h. Remove and immediately place it in an oven at 70 °C for 42 h and remove. Brush all areas of the specimen twice with the wire scratch brush. Hold the brush with the long axis of the brush parallel to the longitudinal axis of the specimen or parallel to the ends as required to cover all areas of the specimen. Apply these strokes to the height and width of the specimen with a firm stroke corresponding to approximately 1.5 kg force. Eighteen to twenty vertical brush strokes are required to cover the sides of the specimen twice and four strokes are required on each end.

NOTE Measure the pressure as follows:

- a) clamp a specimen in a vertical position on the edge of a platform scale and set the scale to zero.
- b) apply vertical brushing strokes to the specimen and note the force necessary to register approximately 1.5 kg.

D.3.3 The procedures described in clause D.3.2 constitutes one cycle (48 h) of weathering test. Continue the procedure for 12 cycles. After 12 cycles of test, dry the specimen to constant weight at 105 ± 5 °C and determine the final oven – dry weight (W_f) of the specimen. The data collected permits calculations of the soil – cement loss of the specimen after the prescribed test of 12 cycles

D.4 Calculation and report

D.4.1 Calculate the soil – cement loss of the specimen as a percentage of the originally calculated oven – dry weight (W_i) of the specimen as follows:

$$\text{Soil – cement loss, per cent} = \frac{W_i - W_f}{W_f} \times 100$$

where

W_i = Oven dry weight;

W_f = Final oven-dry weight.

Annex E

(normative)

Determination of linear expansion on saturation

E.1 Test specimens

Randomly select three full size specimens from the sample of blocks which has been found satisfactory in respect of dimensional and visual requirements. These blocks shall be designated as specimens A, B and C respectively.

E.2 Apparatus

A vernier calliper with a least count of 0.1 mm and length more than that of the block, ventilated or thermostatically controlled oven capable of maintaining temperature of $110^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and a length comparator attached with a dial gauge having a least count of 0.001mm (see Figure E. 1).

E.3 Procedure

E.3.1 Cure the specimens for 28 days.

E.3.2 Remove the specimens from water and dry them in the oven at $60 \pm 5^{\circ}\text{C}$ till they attain constant weight and then allow them to cool down at ambient temperature such that they attain room temperature.

E.3.3 Measure the lengths of the longest dimensions of all the three specimens using vernier calliper and note them as initial length of the specimens, L_{Ai} , L_{Bi} , and L_{Ci} respectively.

E.3.4 Fix a metal point or small strip using water insoluble glue on the top surface of the dried specimens and position the block in the apparatus as shown in Fig. 1.

E.3.5 Now, note down the initial reading of the dial gauge.

E.3.6 Remove the specimens from the apparatus without disturbing the digital dial gauge and then soak them in water for 24 h at room temperature.

E.3.7 After 24 h take out the saturated specimens and position them in the length comparator apparatus such that the metal point fixed on the surface of the block faces the dial gauge tip. Note the final reading of the digital dial gauge. Ensure that the dial gauge in the apparatus is undisturbed throughout the duration of test. The difference between the initial dial gauge reading and final dial gauge reading gives the linear expansion of the specimens, L_{Ae} , L_{Be} , and L_{Ce} respectively, in mm.

E.4 Calculation and report

E.4.1 Calculate the percentage linear expansion on saturation of each specimen as the difference between the initial length and final length after saturation expressed as a percentage of the initial length.

Percentage linear expansion on saturation for specimen

$$A = \frac{L_{Ae}}{L_{Ai}} \times 100;$$

Percentage linear expansion on saturation for specimen

$$B = \frac{L_{Be}}{L_{Bi}} \times 100;$$

Percentage linear expansion on saturation for specimen

$$C = \frac{L_{Ce}}{L_{Ci}} \times 100.$$

E.4.2 Report all results separately for each specimen and as the average for the three specimens.

Linear expansion on= (Le / Li) × 100 saturation (percent)

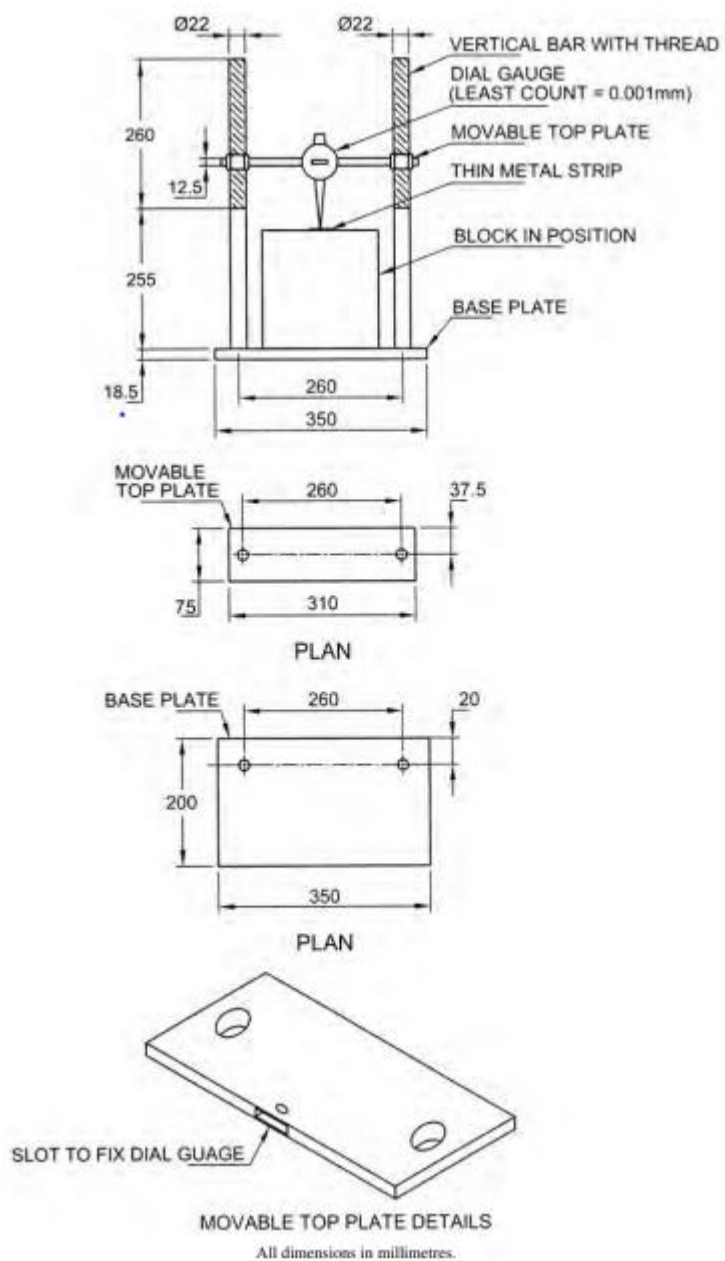


Figure E.1 — Set-up for length comparator

a

$$C_b = \frac{M}{V}$$

—

Soil - × 100

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Bibliography

- [1] ISO 8336:2017 Fibre-cement flat sheets — Product specification and test methods
- [2] IS 1725: 2013 Stabilized soil blocks used in general building construction — Specification

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a

$$C_b = \frac{M}{V}$$

—

Soil $\times 100$

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