DRAFT TANZANIA STANDARD

Concrete blocks (masonry units) Specification

TANZANIA BUREAU OF STANDARDS

 third edition

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0.National foreword

The Tanzania Bureau of Standards is the statutory national standards body for Tanzania, established under the act.No.3 of 1975, amended by act.No.2 of 2009

This Draft Tanzania Standard is being prepared by the Masonry Technical Committee, under the supervision of the Building and Construction Divisional Standards Committee (BCDC)

This Third Edition cancels and replaces the second Edition (TZS 283:2002) which has been technically revised

In the preparation of this Tanzania Standard, reference was made to **Indian Standard IS 2185 (Part 1) – Concrete Masonry Units - specification.**

1 Scope

This Tanzania Draft standard specifies requirements of the following concrete masonry building units which are used in the construction of load-bearing and partition walls

a) Hollow (open and closed cavity) load bearing concrete blocks,
b) Hollow (open and closed cavity) non-load bearing concrete blocks, and
c) Solid load-bearing concrete blocks and non-load bearing concrete blocks.

2 References

For the purpose of this Tanzania Standard, the following references shall apply:

TZS 58 (Part 2): 1980, Aggregates- Natural aggregates for Concrete-Specification.

TZS 62 (Part 4): 1980, Concrete - Methods of testing concrete for strength.

TZS 727 (Part 1): 2002, Cement - Composition, specifications and conformity criteria for common cements

TZS 687:2002, Masonry - Vocabulary.

TZS 849:2005, Building limes- Specification

TZS 4: 1979, Rounding off numerical values

3 Terminology

For the purpose of this Tanzania Standard, the following definition shall apply;

3.1 Block - A concrete masonry unit, either hollow (open or closed cavity), or solid (other than units used for bonding, such as a half block).

3.2 Block Density - The density calculated by dividing the mass of a block by the overall volume, including holes of cavities and end recesses.

3.3 Drying Shrinkage - The difference between the length of specimen which has been immersed in water and then subsequently dried to constant length, all under specified conditions; expressed as a percentage of the dry length of the specimen.

3.4 Face Shells - The two outer plates of the hollow concrete block. These are connected together by webs.

3.5 Gross Area - The total area occupied by a block on its bedding face, including areas of the cavities and end recesses.

3.6 Height- The vertical dimension of the exposed face of a block, excluding any tongue or other device designed to provide mechanical keying.

3.7 Hollow. (Open or Closed Cavity) Block - A block having one or more large holes or a cavity which either pass through the block (open cavity) or do not effectively pass through the block (closed cavity) and having the solid material between 50 and 75 percent of the total volume of the block calculated from the overall dimensions.

3.8 Length - The horizontal dimension of the exposed face of a block, excluding any tongue or other device designed to provide mechanical keying.

3.9 Moisture Movement - The difference between the length of the specimen when dried to constant length and when subsequently immersed in water, all under specified conditions, expressed as a percentage of the dry length of the specimen.

3.10 Webs - The solid sections of the hollow concrete blocks which connect the face shells.

3.11 Width - The external dimension of a block at the bedding plane, measured at right angles to the length and height of the block.

3.12 **Frog** - Depression formed in one or both bed faces of a unit, the total volume of which does not exceed 25% of the gross volume of the unit.

4 Requirements

4.1 Dimensions and Tolerances

Concrete masonry building units shall be made in sizes and shapes to fit different construction needs. They include stretcher, comer, double comer or pier, jamb, header, bull nose, and partition block, and concrete floor units.

4.1.1 *Concrete block - Hollow (open or closed cavity) or solid shall be referred to by its nominal dimensions. The term nominal means that the dimension exclude the thickness of the mortar joint. Actual dimensions (length and depth only) shall be 10 mm short of the nominal dimensions.*

4.1.2 *The nominal dimensions of concrete block shall be as follows:*

Length 400, 450,500 or 600 mm.

Height 100, 125, 150 or 200 mm.

Width 50, 75, 100, 150, 200, 230, 250 or 300 mm.

In addition, block shall be manufactured in half lengths of 200, 250, 230 or 300 mm to correspond to the full lengths. Full length and half-length U-blocks may also be manufactured for the purposes of band and lintels.

The nominal dimensions of the units are so designed that taking account of the thickness or mortar joints, they will produce wall lengths and heights which will conform to the principles of modular co-ordination.

4.1.3 *Blocks of sizes other than those specified in 4.2.1 may also be used by mutual agreement between the purchaser and the supplier. In the case of special concrete masonry units such as wall blocks and ornamental blocks, the specified sizes may not necessarily apply.*

4.1.4 *The variation in the length of the units shall not be more than ± 5 mm and variation in height and width of units, not more than ± 3 mm.*

4.1.5 *Face shells and webs shall increase in thickness from the bottom to the top of the unit. Depending upon the core moulds used, the face shells and webs shall be flared and tapered or straight tapered, the former providing a wider surface for mortar. The thickness of the face shell and web shall be not less than the values given in Table 1.*

Table 1 Minimum Face Shell and Web Thickness

S/n	Nominal block width (mm, min)	Face shell thickness (mm, min)	Thickness of web (mm, min)	Total web thickness per course in any 200mm length of wall.
i	100 or less	25	25	25
ii	100-150	25	25	30
ii	150-200	30	25	30
iv	Over200	35	30	38

4.1.6 *Subject to the tolerances specified in 4.4.1 and provisions of 4.5.1 the faces of masonry units shall be flat and rectangular, opposite faces shall be parallel, and all angles shall be square. The bedding surfaces shall be at right angles to the faces of the blocks.*

4.1.7 *Blocks with Special Faces*

Blocks with special faces shall be manufactured and supplied as agreed upon between the supplier and the purchaser.

4.2 Classification

4.3.1 *Hollow (Open and Closed Cavity) and solid Concrete Block*

The hollow (open and closed cavity) and solid concrete blocks shall conform to the following four grades:

a) *Grade A - These are used as load bearing units and shall have a minimum block density of 1500 kg/m^3 These shall be manufactured for minimum average compressive strengths of 3.5, 4.5, 5.5, 7.0, 8.5, 10.0, 12.5 and 15.0 N/mm^2 respectively at 28 days (see Table 2).*

b) *Grade B - These are also used as load bearing units and shall have a block density between 1100 kg/m^3 and 1500 kg/m^3 These shall be manufactured for minimum average compressive strengths of 2.0, 3.0 and 5.0 N/mm2 respectively at 28 days (see Table 2).*

c) *Grade C – These grades of concrete blocks are used as non-bearing units and shall have a block density of less than 1500 kg/m^3 but not less than 1000 kg/m^3. These shall be manufactured for minimum average compressive strength of 1.5N/mm^2 at 28 days. (see table 2)*

d) *Solid Concrete Block – Grade D*
The solid concrete blocks are used as load bearing units and shall have a block density not less than 1800 kg/m^3. These shall be manufactured for minimum average compressive strength of 4.0 and 5.0N/mm^2 re-spectively (see Table 2).

Table 2-compressive strength and Density of concrete block.

Type	Grade	Density of block kg/m^3	Minimum average Compressive Strength of Units N/mm^2	Minimum Compressive Strength of Individual Units, N/mm^2
Hollow (open and closed cavity) load bearing unit	A(3.5)	Not less than 1500	3.5	2.8
	A(4.5)		4.5	3.6
	A(5.5)		5.5	4.4
	A(7.0)		7.0	5.6
	A(8.5)		8.5	7.0
	A(10.0)		10.0	8.0
	A(12.5)		12.5	10.0
	A(15.0)		15.0	12.0
	B(3.5)	Less than 1500 but not less than 1100	3.5	2.8
	B(5.0)		5.0	4.0
Hollow (open and closed cavity) non-load bearing unit	C(1.5)	Less than 1500 but not less than 1100	1.5	1.2
Solid load bearing unit	D(5.0)	Not less than 1800	5.0	4.0
	D(4.0)		4.0	3.2

4.3 Surface Texture and Finish

4.3.1 *Concrete masonry units can be given a variety of surface textures ranging from a very fine close texture to a coarse open texture by the proper selection, grading, and proportioning of aggregates at the time of manufacture. Textures may also be developed by treating the face of the units while still green by wire brushing or combing, slightly eroding the surface by playing a fine spray of water upon it, and by splitting (split block). Colour maybe introduced by incorporating non-fading mineral pigments in the facing concrete, or by applying a coloured cement grout or paint to the face of the units soon after they are removed from the moulds. Selected coloured aggregates may also be used in the facing and exposed by washing with water or dilute hydrochloric acid followed by thorough washing with water to ensure no traces of acid are left on the surface.*

4.3.2 *Wall made concrete masonry may not require plaster in case of unimportant buildings in low rainfall areas; two or three coats of a cement paint being sufficient to render it resistant to rain water. If, however, it is intended to plaster concrete masonry, the block shall have a sufficiently rough surface to afford a good key to the plaster. Water proofing admixtures may be used for preparing the plaster.*

4.4 Compressive Strength

The minimum compressive strength at 28 days being the average of eight units, and the minimum compressive strength at 28 days of individual units, when tested in the manner described in Annex D shall be as prescribed in Table 2. Materials.

4.5 Drying shrinkage

The average drying shrinkage of units, determined in accordance with 6.7, shall not exceed 0.06% for normal shrinkage units and 0.08% for high shrinkage units.

4.6 Moisture Movement

The moisture movement (average of three blocks) shall not exceed 0.09%.

4.7 Water Absorption

The water absorption, being the average of three units, when determined in accordance with 6.10 not be more than 10 percent by mass.

4.8 Expansion on re-wetting

The average expansion on re-wetting, determined in accordance with 6.8, shall not exceed the actual value obtained for drying shrinkage by more than 0.02%

4.9 Squareness

In the case of units of overall height exceeding 90 mm, any out of squareness of a unit, determined in accordance with 6.5, shall not exceed 2 mm.

5 Marking

Each consignment of units shall be accompanied by dispatch or consignment note in which the following information is given:

a). The manufacture's name, trade name or trade mark;

b). The date of manufacture or related code number;

c). Whether solid or hollow units;

d). The work size;

e). The nominal compressive strength (as given in column 4 of table 2);

f). The average drying shrinkage;

g). In the case of face units having a coloured finish, the colour

6 Inspection, sampling and methods of test

6.1 Inspection

Inspect each unit in the sample for compliance with the requirements of 4.1 and 4.2.

6.2 Sampling test specimen.

6.2.1 *A statistical representative sample of masonry units required for test purposes shall be randomly selected to the mutual satisfaction of the manufacturer, supplier and the purchaser.*

6.2.2 *The blocks required for carrying out the tests laid down in this standard shall be taken a sample of 20 blocks shall be taken from every lot/consignment of 5000 blocks or part thereof from the same grade. size and same batch of manufacture.*

6.2.3 *The required number of blocks shall be taken at regular intervals during the loading of the vehicle or the unloading of the vehicle depending on whether sample is to be taken before delivery or after delivery. When this is not practicable, the sample shall be taken from the stack in which case the required number of blocks shall be taken at random from across the top of the stacks, the sides accessible and from the interior of the. Stacks by opening trenches from the top.*

6.2.4 *The sample of blocks shall be marked for future identification of the consignment it represents. The blocks shall be kept under cover and protected from extreme conditions of temperature, relative humidity and wind until they are required for test. The tests shall be undertaken as soon as practicable after the sample has been taken.*

6.3 Number of Tests

6.3.1 *All the 20 blocks shall be checked for dimensions and inspected for visual defects.*

6.3.2 *Out of the 20 blocks, 3 blocks shall be subjected to the test for block density, 8 blocks to the test for compressive strength, 3 blocks to the test for water absorption, and 3 blocks to the test for drying shrinkage and later to the test for moisture movement. The remaining 3 blocks shall be reserved for retest for drying shrinkage and moisture movement, if a need arises.*

6.4 Test for dimension

6.4.1 *Apparatus*

6.4.1.1 *Overall dimensions shall be measured with a Steel scale graduated in 1 mm divisions. Face shell and web thickness shall be measured with a caliper rule graduated in 0.5 mm divisions and having parallel jaws not less than 15 mm and not more than 25 mm in length.*

6.4.2 *Specimens*

Twenty full size units shall be measured for length, width and height. Cored units shall also be measured for minimum thickness of face shells and webs.

NOTE - These specimens shall be used for another test also.

6.4.3 *Measurement and report*

6.4.3.1 *Individual measurements of the dimensions of each unit shall be read to the nearest division of the scale or caliper and the average recorded.*

6.4.3.2 *Length shall be measured on the longitudinal center line of each face, width across the top and bottom bearing-surfaces at midlength, and height on both faces at midlength. Face-shell thickness and web thickness shall be measured at the thinnest point of each such element -15 mm above the mortar-bed plane. Where oppo-site face-shells differ in thickness by less than 3 mm, their measurements shall be averaged. Sash grooves, dummy joints, and similar details shall be disregarded in the measurements.*

6.4.3.3 *The report shall show the average length, width and height of each specimen, and the minimum face shell and web thickness and total web thickness in 200 mm length of walling per course as an average for the 20 specimens.*

6.5 Test for squareness

In the case of units of overall height exceeding 90 mm, test both ends and both sides of each unit as follows:

Use an engineer's square having a blade of length at least equal to the height of the unit and so place the inner face of the stock against each bed-face of the unit in tum and at right angles to the face being tested that the

blade touches the face. If it is not in contact with both edges of the face being tested, take the distance (measured to the nearest one millimetre) of the blade from the edge furthest from the adjacent to the stock as the out-of-squareness of the face. Check for compliance with the requirements in 4.9.

6.6 Compressive strength test.

6.6.1 *Apparatus*

6.6.1.1 *Testing machine*

A testing machine of sufficient capacity for the test and equipped with a means of providing the rate of loading of 15 Mpa/min ± 3 MPa/min (as calculated using the area of the bed-face (see 6.6.2) of the unit being tested) and in which the bearing faces of both platens are at least as large as (and preferably larger than} the bed-faces of the unit being tested, and do not depart from plane by more than 0.05mm.

6.6.1.2 *Capping table*

A table or bench that has a non-absorbent surface which is plane to within 0.15mm, is level in two directions at right angles to each other and is sufficiently rigid and so supported as to prevent it from being measurably deflected during the capping process.

6.6.1.3 Measuring device

A measuring device capable of measuring a reduction in the height of the unit under test to the nearest 0.5 mm.

6.6.2 *Area of bed-face*

Measure to the nearest one millimeter the length and width of the bed-faces of each unit, calculate the overall area of each of these faces, and use the smaller of the two areas for the calculation of the compressive strength.

6.6.3 *Preparation of test specimens*

6.4.1 Cap each bed-face of each unit (see 6.4) in the following manner:

Mix a quantity of capping mortar, consisting of one part (by mass) of Portland cement to one part (by mass) of calcined gypsum (plaster of paris), with enough water to allow the mortar to spread evenly.

6.4.2 Completely re-fill with capping mortar any frog(s) in the solid units.

6.4.3 Coat the surface of capping table with appropriate release material (e.g. a film of oil or a sheet of absorbent paper) and spread a quantity of capping mortar on the coated surface. Place one of the bed-faces on the mortar and, while maintaining the vertical faces of the unit at right angles to the surface of the table, so press the unit down firmly, with a single movement into the mortar as to ensure that the average thickness of the cap does not exceed 5mm. Trim the extruded mortar flush with the vertical faces of the unit. Where the cap covers the cavity or cavities in a hollow unit, make several small holes in the cap through which water can drain.

NOTE - Do not patch caps after they have set, but remove imperfect caps and replace with sound ones.

6.4.4 As soon as the cap has hardened sufficiently, slide the unit from the surface of the table and repeat the capping process on the opposite side of the unit, ensuring that the two capped faces are parallel to each other by levelling the hardened capped face in two directions (at right angles to each other) by means of a spirit level. As soon as the second cap has hardened sufficiently, slide the unit from the surface of the table, leave it to stand for 2 hours, and then, before testing, immerse it in clean water maintained at a temperature of 22°c - 25 °C, for a period of at least 24 hours.

6.6.4 *Procedure*

6.6.4.1 Test each unit within 5 minutes of the time of its removal from the water.

6.6.4.2 Wipe clean the bearing surface of the platens of the testing machine and remove any loose sand or other material.

6.6.4.3 So position the unit in the testing machine that it rests on one capped face with its centre of gravity over the centre of the tower platen of the machine. Do not use packing pieces between units and the platens.

6.6.4.4 Record, in Newtons, the maximum failing load

NOTE - The maximum failing load is reached when:

a). no greater load can be sustained by the unit, or
b). the height of the unit is reduced by 5% of its original height, whichever occurs first.

6.6.5 *calculation.*

6.6.5.1. Calculate, to the nearest 0.01 MPa, the compressive strength of each unit as follows:

$$\text{Compressive strength, Mpa} = \frac{\text{Failure load,N}}{\text{Area of load-face,mm}^2}$$

Then calculate the average compressive strength, to the same accuracy as the individual results, as the arithmetic mean of the individual values of the 5 or 12 units, as relevant (see table 2).

6.6.5.2. Record, to the nearest 0.1 MPa, the individual and average compressive strengths of the units and check for compliance with the relevant requirement of 4.4.

6.7 Drying shrinkage.

6.7.1 *Apparatus.*

6.7.1.1 *Oven*

A forced-draught drying oven capable of maintaining a temperature of 50°C-55 °C and a relative humidity of 15 % -25%, and of size such as to allow a free air space of width at least 20 mm around each test specimen.

NOTE - This relative humidity may be maintained by the inclusion of trays of saturated calcium chloride solution. The trays should provide a total exposed area of at least $1m^2$ per $1m^3$ of volume of oven and should contain sufficient solid calcium chloride to show above the surface of the solution throughout the test.

6.7.1.2 Gauge

A gauge capable of measuring the gauge length (see 6.7.4) of the test specimens to an accuracy of 0.002 mm

6.7.1.3 *Steel balls, of nominal diameter 6 mm*

6.7.1.4 Desiccator

A desiccator that is large enough to accommodate the test specimens and that contains a saturated solution of calcium chloride (see the NOTE in 6.7.1.1 above).

6.7.2 *Preparation of test specimens.*

6.7.2.1. *Cut from each unit (see 6.2) a test specimen of length (paraffel to the length of the unit), approximately 200 mm and cross-section at least 70mm x 25 mm.*

6.7.2.2. *Using an epoxy resin compound, so fix a steel ball into the centre of each end of each specimen that half of the surface of the ball protrudes.*

6.7.2.3. *After the resin has set sufficiently for the specimen to be handled, clean the exposed surfaces of the steel balls and grease them to prevent corrosion.*

6.7.2.4. *Use the outer extremities of the balls as reference points.*

6.7.3 ***Procedure.***

6.7.3.1 *Immerse the specimens in clean water maintained at temperature of 22°C – 25°C, for a period of 4 days.*

6.7.3.2 *Remove the specimens from the water and wipe off any excess water with a damp cloth, wipe the grease from the steel balls, and immediately measure the length between the reference points (measurement A).*

6.7.3.3 *After measuring the distance, re-grease the steel balls and dry the specimens in the drying oven for a period of at least 48 hours. (Do not place wet specimens in the oven together with partially dried specimens).*

6.7.3.4 *Remove specimens from the oven, allow them to cool to a temperature of 22°C -25°C in the desiccator, wipe the grease from the steel balls and again measure the length between the reference points.*

6.7.3.5 *Repeat this drying and cooling procedure (but using drying periods of 24 hours) until the difference between consecutive measurements is less than 0.004 mm*

6.7.3.6 *Take the final reading as the dry length (measurement B).*

6.7.3.7 *Calculate the drying shrinkage of each specimen (as given in 6.6.4), and record the arithmetic mean of the six individual results as the average drying shrinkage of the units and check for compliance with the relevant requirement of 4.7.*

6.7.4 ***Calculation.*** *Calculate the drying shrinkage of each specimen as follows:*

$$\textbf{Drying shrinkage, \%} = \frac{\text{measurement A} - \text{measurement B}}{\text{gauge length}} \times 100$$

Where the gauge length is the drying length (measurement rounded off to the nearest one millimetre) minus 12mm

Record the individual results to the nearest 0.001% and average result to the nearest 0.01%.

6.8 Expansion on re-wetting test

Apparatus

Gauge as in 6.7.1.2

6.8.1 Test specimens.

Use the six test specimens previously used in the test for drying shrinkage (see 6.6).

6.8.2 Procedure.

After completion of the test for drying shrinkage given in 6.7, re-grease the steel balls and immerse the test specimens in clean water maintained at a temperature of 22°C-25°C, for a period of 4 days.

6.8.3 Remove the specimens from the water and wipe off any excess water with a damp cloth, wipe the grease from the steel balls and immediately measure the length between the reference points (measurement A). Regard this as the final wet length.

6.8.4 Use the dry length obtained in 6.7.3 as measurement B.

6.8.5 calculate the expansion on re-wetting of each specimen (as given in 6.7.4), and the arithmetic mean of the six individual results as the average expansion on re-wetting of the units and check for compliance with the requirement of 4.8.

6.8.6 Calculation

Calculate the expansion on re-wetting of each specimen as follows:

$$\text{Expansion on re-wetting, \%} = \frac{\text{mearement A} - \text{measurement B}}{\text{gauge length}} \times 100$$

where the gauge length is the dry length (measurement B rounded off to the nearest one millimeter) minus 12 mm.

Record the individual results to the nearest 0.001% and the average results to the nearest 0.01%.

6.9 Method for the determination of block density

6.9.1 *Procedure*

Three blocks taken at random from the samples selected, shall be dried to constant mass in a suitable oven heated to approximately 100°C. After cooling the blocks to room temperature, the dimensions of each block shall be measured in centimetres (to the nearest millimetre) and the overall volume computed in cubic centimetres. The block shall then be weighed in kilograms (to the nearest 10g) and the density of each block calculated as follows:

$$\text{Density} = \frac{\text{mass of block,in kg}}{\text{volume of specimen,in cm}^3} \times 10^6 \text{ kg/m}^3$$

6.9.2 *The average for the three blocks shall be taken as the average density.*

6.10 Method for the determination of water absorption

6.10.1 *Apparatus*

6.10.1.1 *The balance used shall be sensitive to within 0.5 percent of the mass of the smallest specimen tested.*

6.10.1.2 *Three full-size units shall be used.*

6.10.2 *Procedure*

6.10.2.1 *Saturation*

The test specimens shall be completely immersed in water at room temperature for 24 h. The specimens shall then be weighed, while suspended by a metal wire and completely submerged in water. They shall be removed from the water and allowed to drain for one minute by placing them on a 10 mm or coarser wire mesh, visible surface water being removed with a damp cloth and immediately weighed.

6.10.2.2 *Drying*

Subsequent to saturation, all specimens shall be dried in a ventilated oven at 100 °C to 115 °C for not less than 24 h and until two successive weighing at intervals of 2 h show an increment of loss not greater than 0.2 percent of the last previously determined mass of the specimen.

6.10.3 *Calculation and report*

Calculate the water absorption as follows:

$$\text{Water absorption, kg/m}^3 = \frac{A-B}{A-C} \times 1000$$

$$\text{Water absorption, percent} = \frac{A-B}{B} \times 100$$

Where

A= wet mass of units, in kg;
B= dry mass of units, in kg; and
C= suspended immersed mass of units, in kg.

6.10.4 *Report*

Report all results separately for each unit and as the average for the three units.

ANNEX A
(normative)
Typical materials recommended for use in the manufacture of concrete masonry units.

A.1 Cement

Cement used in manufacturing blocks shall complying with TZS 727

A.2 Aggregates

The aggregates used in the manufacture of blocks at the mixer or the mixing platform shall be clean and free from deleterious matter and shall conform to the requirements of TZS 2202.

A.3 Water

The water used in the manufacture of concrete masonry units shall be free from matter harmful to concrete or reinforcement, or matter likely to cause efflorescence in the units.

A.3 Additives or Admixtures

Additives or admixtures may be added either as additives to the cement during manufacture, or as admixtures to the concrete mix. Additives or admixtures used in the manufacture of concrete masonry units may be:

a) accelerating, water reducing, air-entraining and super plasticizer
b) Waterproofing agents
c) Colouring pigments.