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TANZANIA STANDARD

Architectural Cast Stone - Specification

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Tanzania Bureau of Standards
P O Box 9524
Dar es Salaam
Tel: +255 (22) 2450206/2450949/2450298
Fax: +255 22 2450298
E-mail: info@tbs.go.tz
Website: www.tbs.go.tz
Website: www.tbs.go.tz

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0 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 BCDC 2 Masonry Technical Committee under the supervision of the Building and Construction Divisional Standards committee (BCDC).

In the preparation of this draft Tanzania Standard assistance was derived from ASTM C1364 – 25 Standard Specification for Architectural Cast Stone published by American Society for Testing and Materials (ASTM)
Architectural cast stone is a manufactured masonry material used in building construction and architectural applications as an alternative to natural stone. It is commonly used for facades, walling, columns, copings, sills, trims, mouldings, balustrades and other decorative or functional elements.

1 Scope

1.1 This specification includes the physical properties, sampling, testing, tolerance, and appearance requirements for architectural cast stone.

1.2 Cast stone units covered under this specification include both wet cast and vibratory dry tamp products. Production methods of cast stone can vary among manufacturers; many production methods are acceptable provided the delivered cast stone meets the requirements of this specification.

2 Normative references

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

ASTM Standards:

A615/A615M Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement

C33/C33M Specification for Concrete Aggregates C150/C150M Specification for Portland Cement C173/C173M Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method C231/C231M Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method C260/C260M Specification for Air-Entraining Admixtures for Concrete

C426 Test Method for Linear Drying Shrinkage of Concrete Masonry Units

C494/C494M Specification for Chemical Admixtures for Concrete

C595/C595M Specification for Blended Hydraulic Cements

C618 Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

C666/C666M Test Method for Resistance of Concrete to Rapid Freezing and Thawing (Withdrawn 2024)

C979/C979M Specification for Pigments for Integrally Colored Concrete

C989/C989M Specification for Slag Cement for Use in Concrete and Mortars

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C1157/C1157M Performance Specification for Hydraulic Cement
C1194 Test Method for Compressive Strength of Architectural Cast Stone
C1195 Test Method for Absorption of Architectural Cast Stone
D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials
D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates 2.2 TMS Standards: TMS 404 Standard for Design of Architectural Cast Stone

3 Terms and definitions

3.1 cast stone, n—an architectural precast concrete building unit intended to simulate natural cut stone.
3.2 vibrant dry tamp (dry cast) products, n—cast stone manufactured from zero slump concrete densely compacted by apparatus. (See Note 1.)
3.3 wet cast products, n—cast stone manufactured from measurable slump concrete consolidated by apparatus. (See Note 1.)
NOTE 1—Apparatus used in the production of cast stone may include automatic, semi-automatic, or manual devices that deploy internal or external vibration, vibrant tamping, vibration under pressure, centrifugal casting, or combinations of these techniques to achieve the specified physical properties.

4. Materials and Design

4.1 Raw Materials—Materials shall conform to the following specifications:
4.1.1 Cement:
4.1.1.1 Portland Cement—Specification C150/C150M.
4.1.1.2 Blended Cement—Specification C595/C595M.
4.1.1.3 Hydraulic Cement—Specification C1157/C1157M.
4.1.2 Aggregates—Specification C33/C33M, except for grading requirements.
4.1.3 Coloring Pigment—Specification C979/C979M, except that carbon black pigment shall not be used.
4.1.4 Reinforcement—Specification A615/A615M.
4.1.5 Chemical Admixtures—Chemical admixtures shall conform to the following applicable specifications:
4.1.5.1 Air Entraining Admixtures—Specification C260/ C260M, except for vibrant dry tamp products.
4.1.5.2 Water Reducing and Accelerating Admixtures— Specification C494/C494M.
4.1.5.3 Other Constituents—Integral water repellents and other chemicals for which no ASTM standard exists shall be previously established as suitable for use in concrete by proven field performance or through laboratory testing.

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4.1.6 Ground Slag—Specification C989/C989M.

4.1.7 Fly Ash or Natural Pozzolan—Specification C618

4.2 Design—Samples shall be submitted for approval of color and texture. The manufacturer shall prepare drawings for approval showing shapes, sizes, reinforcement, exposed faces, and anchorage provisions. The purchaser or their authorized representative shall approve the samples and drawings before manufacture.

4.3 Reinforcement:

4.3.1 Reinforcement shall be new billet steel reinforcing bars meeting the requirements of Specification A615/A615M unless specified otherwise by the purchaser.

4.3.2 Reinforce units when necessary for safe handling and structural stress.

4.3.3 Reinforcement shall be noncorrosive where faces exposed to weather are covered with less than 38 mm of concrete material. All reinforcement shall have minimum coverage of twice the diameter of the bars.

4.3.4 Area of reinforcement in units greater than 600 mm in more than one direction shall be not less than 0.25 % of the cross-section area [in that direction]. Units less than 600 mm in both their length and width dimension shall be non-reinforced unless otherwise specified

5. Physical Requirements

5.1 Compressive Strength at 28 days after manufacture, not less than 45 MPa, when tested in accordance with Test Method C1194.

5.2 Absorption at 28 days after manufacture, not greater than 6.0%, when tested in accordance with Test Method C1195.

5.3 Air Content - Provide sufficient air content to meet the freeze-thaw requirements for wet cast products, when the air content is tested in accordance with Test Method C173/C173M or Test Method C231/C231M.

5.4 Field Testing of cast stone shall be in accordance with Test Methods C1194 and C1195. Field tested specimens shall have an average minimum compressive strength of 85% with no single specimen testing less than 75% of the design requirement in accordance with TMS 45MPa, whichever is greater.

5.5 Resistance to Freezing and Thawing:

5.5.1 The cast stone shall be tested using Test Method C666/C666M, Procedure A, except the method of evaluation is to be based on cumulative percent loss in mass and not relative dynamic modulus of elasticity and durability factor. Follow the procedure modifications to Test Method C666/C666M in 5.5.1.1 through 5.5.1.7.

5.5.1.1 After the cast stone is 14 days of age, saw-cut three 76 by 102 by 406 mm beams from a single sample of cast stone to represent three specimens for a single test. One surface of each beam shall be from the exposed, formed face of the sample and the remaining sides shall be saw
cut. The allowable size tolerance of the specimens shall be ± 3 mm.

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5.5.1.2 Do not oven dry the beam specimens until all testing for resistance to freezing and thawing has been completed.

5.5.1.3 Submerge each beam specimen in lime-saturated water at 23 ± 1.7°C at least 24 h prior to subjecting to freezing and thawing as described in Test Method C666/C666M, Procedure A. Inspect each specimen at intervals not to exceed 100 freeze thaw cycles and collect the spalled residue caused by freeze-thaw cycling from each specimen individually to monitor loss in mass during testing.

NOTE 2—Residue collection may occur at frequencies less than 100 cycles when desired, such as for research purposes or when evaluating mix design changes.

5.5.1.4 For each specimen, oven dry the residue and deter mine its mass until the loss in mass due to drying is not more than 0.2 % in 2 h of drying. Record the data individually and cumulatively for each specimen throughout the test until 300 cycles are completed or the mass lost is at least 10 %, whichever occurs first.

5.5.1.5 Specimens shall then be oven dried at a temperature of 212 to 230°F (100 to 110°C) until the loss in mass due to drying is not more than 0.1 % in 48 h of drying. Remove each specimen from the oven and allow to cool at room temperature for approximately 30 minutes before measuring the final dry mass. The initial dry mass of each specimen is considered to be the final dry mass of the specimen plus the total dry mass of residue collected from the beam throughout the test.

5.5.1.6 Calculate the cumulative percent mass loss (CPWL) for each beam specimen as follows:

$$CPWL\ (Beam),\ \% = \frac{S}{S+B} \times 100 \qquad (1)$$

where:

$CPWL\ (Beam)$ = cumulative percent mass loss,
S = total dry mass of spalled material, and
B = oven dried beam mass at the end of the test.

5.5.1.7 Calculate the CPWL for the sample. The CPWL of the sample is the average CPWL (Beam) of the three specimens.

5.5.1.8 It is not possible to specify the precision of the procedure in this specification for freeze-thaw because data is not yet available. Since there is no accepted reference material suitable for determining the bias of results of this test, no statement on bias is being made.

5.5.2 The CPWL shall be less than 5.0 % after 300 cycles of freezing and thawing.

6. Dimensions and Permissible Variations

6.1 Cross section dimensions shall not deviate by more than 3 mm from approved dimensions.

6.2 Length of units shall not deviate by more than length/360 3 mm, whichever is greater, not to exceed 6 mm.

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7. Sampling and Testing

7.1 Sample and test units of cast stone for compressive strength and absorption in accordance with Test Methods C1194 and C1195, respectively.
7.2 Freeze/thaw durability shall be based on tests of cast stone units of any configuration or dimension made with the same materials, concrete mix design, manufacturing process, and curing method, conducted in accordance with 5.5 and within 24 months of production of the units.
7.3 Total linear drying shrinkage shall be based on tests of cast stone units of any configuration or dimension made with the same materials, concrete mix design, manufacturing process, and curing method, conducted in accordance with Test Method C426 and within 24 months of production of the units.
7.4 Visually examine units in accordance with Section 8.
7.5 Visually examine color differences between units and the approved sample under daylight illumination as defined under Spectral Power Distribution in paragraph 5.1.1.1 of Practice D1729.
7.6 Instrumentally examine color differences, if required, in accordance with Test Method D2244.

8. Visual Inspection

8.1 All surfaces intended to be exposed to view shall have a fine-grained texture similar to natural stone, with no air voids in excess of 0.8 mm and the density of such voids shall be less than three occurrences per any 645 mm^2 and not obvious under direct daylight illumination from a 1.5m distance, unless otherwise specified.
8.2 Minor chipping resulting from shipment and delivery shall not be grounds for rejection. Minor chipping shall not be obvious under direct daylight illumination from a 6m distance.
8.3 Units shall exhibit a texture approximately equal to the approved sample when viewed under direct daylight illumination at a 3m distance.
8.4 The occurrence of crazing or efflorescence shall not constitute a cause for rejection.

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9. Permissible Variation in Color

9.1 Total Color Difference—Not greater than 6 units from the approved sample or between units of comparable age subjected to similar weathering when tested in accordance with the color difference equation in paragraph 6.2.1 of Test Method D2244.
9.2 Hue Difference—Not greater than 2 units from the approved sample or between units of comparable age subjected to similar weathering when tested in accordance with the color difference equation in paragraph 6.2.7 of Test Method D2244.

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10. Rejection

10.1 If the shipment fails to conform to physical or visual requirements in Sections 5 and 7, the manufacturer may recall the shipment, sort it, and new specimens shall be selected by the purchaser and tested at the expense of the manufacturer. If the second set of specimens fails to conform to the test requirements, the entire shipment shall be rejected. 10.2 Units shall be visually inspected and tested prior to installation.

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