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Replacing JC 746-1999

Concrete tiles

混凝土瓦

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Foreword

This standard is the revision of JC 746-1999 “Concrete tiles”.

The main changes in this standard as compared with JC 746-1999 are as follows:

- REDEFINE the technical indicators and judgment rules of the bearing capacity;
- ADD the thermal resistance performance and test methods;
- ADD the technical indicators and test methods of the mass standard deviation;
- ADD the provisions on the radionuclide limit of the concrete tiles as manufactured from industrial waste residue;
- ADD the inspection report filling format;
- SIMPLIFY the test methods of covering width;
- CANCEL the provisions of dividing into three levels - excellent products (A), first class products (B), and qualified products (C) - based on the physical and mechanical properties;

Appendix A, Appendix B, Appendix C, Appendix D, and Appendix E of this standard are normative appendixes, AND Appendix F is an informative appendix.

This standard shall, from the date of implementation, replace JC 746-1999.

This standard was proposed by China Building Materials Industry Association.

This standard shall be under the jurisdiction of the National Standardization Technical Committee for Cement Products.

The responsible drafting organizations of this standard: Liaoning Institute of Building Materials Science, Lafarge Roofing System (China) Limited.

The participating drafting organizations of this standard: China Construction Northeast Design and Research Institute, Changzhou Huamei Building Materials Co., Ltd., Wuxi Fuji Colored Tiles Co., Ltd., Harbin Langen Colored Tiles Manufacturing Limited Liability Company, Shanghai Sheshanhong New Building Materials Co., Ltd., Quanzhou Qunfeng Machinery Manufacturing Co., Ltd., Liaoning Xinxin Group Building Materials Co., Ltd., Beijing Yipinhong

Concrete tiles

1 Scope

This standard specifies the definition, structure, symbol, abbreviation, classification, specification, identification, general rules, requirements, sampling, test methods, inspection rules, marking, product quality certificate, instruction manual, packaging, storage and transportation of concrete tiles.

This standard is applicable to concrete sloping roof tiles made of cement, fine aggregate, water, and other main raw materials through mixing, extrusion, hydrostatic molding, or other molding methods AND their matching concrete fitting tiles. The concrete tiles may be native tiles, colored tiles or surface treated tiles.

2 Normative references

The provisions in following documents become the provisions of this Standard through reference in this Standard. For the dated references, the subsequent amendments (excluding corrections) or revisions do not apply to this Standard; however, parties who reach an agreement based on this Standard are encouraged to study if the latest versions of these documents are applicable. For undated references, the latest edition of the referenced document applies.

GB 175 Portland cement and ordinary portland cement

GB 1344 Portland blast furnace slag cement, Portland pozzolana cement, and Portland flay-ash cement

GB/T 1596 Fly ash used for cement and concrete

GB/T 2015 White portland cement

GB 6566 Limit for radionuclides in building materials

GB 8076 Concrete admixtures

GB 12958 Composite portland cement

GB/T 14684 Sand for construction

JC/T 539 Pigments used in concrete and mortar and their test method

JC/T 870 Colored portland cement

JGJ 63 Standard of water for concrete

YBJ 205-1984 Technical requirements for blast furnace heavy crushed slag for concrete use

3 Definitions, structures, symbols and abbreviations

The following terms and definitions apply to this standard.

3.1 Definition

3.1.1

Concrete tiles

It is a general term of roofage tiles and fitting tiles made of concrete.

3.2.2

Concrete roofage tiles

It refers to the building product made of concrete AND paved on the sloping roof to function as tiled roof together with the fitting tiles (shortly referred to as the roofage tiles).

3.1.2.1

Concrete roofage wavy tiles

It refers to the tiles paved on the sloping roof, for which the cross section is in wave shape (shortly referred to as wavy tiles).

3.2.2.2

Concrete roofage flat tiles

It refers to the tiles paved on the sloping roof, for which the cross section edge is in straight line shape (shortly referred to as flat tiles).

3.1.3

Concrete fittings tiles

It refers to the building products made of concrete AND paved on the specific location of the sloping roof to satisfy the special functional

B_x - Lower base width of the roofage tile for which the front projection is right angle trapezoidal, in millimeters (mm);

b_1 - Covering width of the roofage tile, in millimeters (mm);

b_2 - Overlap width of the roofage tile, in millimeters (mm);

d - Ridge height of the roofage tile, in millimeters (mm);

F - Bearing capacity, in Newton (N);

F_1, F_2, F_3, ... F_n - Measured bearing capacity value of single sample, in Newton (N);

F_{av} - Measured average of the carrying capacity, in Newton (N);

F_{avf} - Measured average of the bearing capacity after freezing, in Newton (N);

F_e - Standard value of bearing capacity, in Newton (N);

F_f - Bearing capacity after freezing, in Newton (N);

F_{1f}, F_{2f}, F_{3f} - Measured value of bearing capacity of single roofage tile after freezing, in Newton (N);

F_i - Measured value of bearing capacity of the i^{th} tile, in Newton (N);

L - Length of the roofage tile, in millimeters (mm);

L_x - Length of the oblique side of the roofage tile for which the front projection is a right angle trapezoid, in millimeters (mm);

L_z - Length of the right-angle side of the roofage tile for which the front projection is a right-angle trapezoid, in millimeters (mm);

l - Hanging length of the roofage tile, in millimeters (mm), $l = [(l_1 \times l_2)/2]$;

l_1 - Left hanging length of roofage tile at normal use, in millimeters (mm);

l_2 - Right hanging length of roofage tile at normal use, in millimeters (mm);

m_{av} - Measured average of mass, in grams (g);

m_1, m_2, m_3 ... m_n - Measured mass of single sample, in grams (g);

m_b - The saturated mass of the sample, in grams (g);

m_0 - The dry mass of the sample, in grams (g);

n - Number of samples, in pieces;

W - Water absorption, %;

σ - Standard deviation of bearing capacity, in Newton (N);

σ_m - Standard deviation of mass, in grams (g).

3.4 Abbreviations

English abbreviations of different kinds of concrete tiles are as follows:

CT - Concrete tiles;

CRT - Concrete roofage tiles;

CRWT - Concrete roofage wavy tiles;

CRFT - Concrete roofage flat tiles;

CFT - Concrete fitting tiles;

CST - Concrete ridge tiles;

CUFT - Concrete unidirectional ridge tiles;

CTST - Concrete three-way ridge tiles;

CFDT - Concrete four-way ridge tiles;

CFRT - Concrete flat ridge tiles;

CSRT - Concrete slanting ridge head tiles;

CDFT - Concrete patterned ridge tiles;

CCT - Concrete cornice tiles;

CCST - Concrete cornice sealing tiles;

CCTT - Concrete cornice top tiles;

CVT - Concrete ventilation tiles;

CVPT - Concrete ventilation pipe tiles;

CDT - Concrete drain tiles.

4 Classification, specification and identification

4.1 Classification

Concrete tiles are divided into: concrete roofage tiles and concrete fitting tiles. AND the concrete roofage tiles are further divided into: roofage wavy tiles and roofage flat tiles.

4.2 Specifications

The specifications of the concrete tiles are expressed in terms of length by width (mm).

Note: if the front projection of the concrete tile shape is non-rectangular, the specification shall be expressed in terms of the product of two sides which can represent its area. If the front projection is the right angle trapezoid, the specification shall be expressed in terms of the right-angle side length by the waist center line length.

4.3 Identification

The concrete roofage tiles are identified by classification, specifications and standard numbers.

Example: Concrete roofage wavy tile of specification 430 mm × 320 mm is identified as:

CRWT 430 × 320 JC/T 746-2007

Note: it may add the product name in the identification.

5 General provisions

5.1 Raw materials

5.1.1 The cement shall comply with the requirements of GB 175, GB 1344, GB 12958, GB/T 2015 and JC/T 870.

5.1.2 Aggregate shall comply with the requirements of GB/T 14684.

5.1.3 When using hard and dense industrial waste as an aggregate, it shall not have adverse effects on the quality of concrete tiles; AND the relevant corresponding technical requirements shall comply with the provisions of YBJ 205-1984.

6.3.2.3 There is no specific requirement for the bearing capacity of the concrete fitting tiles.

6.3.3 Thermal resistance

After the concrete colored tile is subjected to thermal resistance test, its surface coating shall be in good condition.

6.4.4. Water absorption

The water absorption of concrete tiles shall not be greater than 10.0%.

6.3.5 Impermeability

After the concrete tiles are subjected to the impermeability test, the water droplets shall not appear on the back of the tile.

6.3.6 Frost resistance

After the concrete roofage tiles have been subjected to the frost resistance test, their bearing capacity is still not less than the standard value of bearing capacity. At the same time, the appearance quality shall comply with the provisions of Clause 6.1 of this standard.

6.3.7 Radionuclide limit

As for the concrete tiles made of industrial waste residues, the radionuclide limit shall comply with the provisions of GB 6566.

6.4 Concrete tiles for special performance

The technical indicators and test methods of the concrete tiles for special performance shall be as negotiated between the supplier and the purchaser.

7 Sampling

7.1 Method

It shall adopt random sampling. Before sampling, it shall determine the sampling plan, the samples taken shall be representative, the samples shall be taken from the finished product yard, AND the curing period shall be not less than 28 d. On the sample list, it shall indicate whether it is plain tile or colored tile, the tile ridge height, and the covering width.

7.2 Quantity

8.2.3 Thermal resistance and water absorption

The thermal resistance and water absorption test be conducted in accordance with the provisions of Appendix C of this standard.

8.2.4 Impermeability

The impermeability test shall be conducted in accordance with the provisions of Appendix D of this standard.

8.2.5 Frost resistance

The frost resistance test shall be conducted in accordance with the provisions of Appendix E of this standard.

8.2.6 Radionuclide limit

Radionuclide limits are in accordance with GB 6566.

9 Inspection rules

9.1 Inspection classification

Inspection is divided into exit-factory inspection and type inspection.

9.2 Exit-factory inspection

9.2.1 Each batch of exit-factory products shall be subjected to the exit-factory inspection.

9.2.2 The exit-factory inspection items include appearance quality, allowable dimensional deviation, impermeability, and bearing capacity.

9.3 Type inspection

9.3.1 A type inspection shall be carried out in any of the following cases:

a) When the new product manufacturing is subjected to trial production assessment;

b) After the formal production, when the significant change of raw materials, processes and so on may affect the product performance;

c) During normal production, once a year;

10.2 Product quality certificate

During product exit-factory delivery, it must provide the product quality certificate. The product quality certificate shall at least include the following information:

a) The name of the manufacturer;

b) Lot number;

c) Date of exit-factory;

d) Certificate number:

e) Product trademark;

f) Marking;

g) Inspection institute and inspector signature.

10.3 User manual

For the convenience of use, the supplier shall provide the user manual for the concrete tiles, introducing the product shape and structure: tile claw height, fixation hole position, tile ridge height, covering width, mass, site construction method, and reference number of use.

11 Packaging, storage and transportation

11.1 Packaging

11.1.1 The product may be in bulk or packaged as needed.

11.1.2 The product may be packed using bundles, brackets or other methods.

11.1.3 It is preferable for the products to be respectively packaged based on types, colors, and so on.

11.1.4 It shall take effective measures to protect the front surface of the product.

11.1.5 If there is special need, it may be packaged in accordance with the user requirements.

11.2 Storage

Appendix A

(Normative)

Detection method of appearance quality and allowable dimensional deviation

A1 Measuring gauges

a) Steel ruler: range is 0 mm ~ 600 mm AND scale value of 1 mm.

b) Feeler.

c) I-square: the inner corner perpendicularity tolerance is ±1°, the inner corner length is: 1000 mm × 600 mm, AND the scale value is 1 mm.

A2 Appearance quality

The appearance quality is visually inspected by the naked eye and measured with steel ruler.

A2.1 Corner missing

As for the corner missing, MEASURE the two projection sizes of the damage plane on the front surface of the sample along the length direction and the width direction.

A2.2 Tile claw defects

USE the steel ruler to measure the remaining part of the tile claw.

A2.3 Cracks

When observing and judging the unclear cracks with naked eyes, it may use a damp cloth to wipe the sample surface, AND the crack will become clear because the cracks absorb water quickly.

A2.4 Coating

In the case of adequate light, USE the normal vision to visually observe the sample of an area of about 1 m^2, to judge whether the sample surface coating is complete.

A3 Allowable dimensional deviation

A3.1 Length

From the left side and right side of the sample, MEASURE the sample length; USE the absolute value of the maximum difference between either length and its specified length as the detection result, which is rounded off to 1 mm.

A3.2 Width

From the upper end and lower end of the sample, MEASURE the sample width; USE the absolute value of the maximum difference between either width and its specified width as the detection result, which is rounded off to 1 mm.

Note:

1) In accordance with the functional requirements, when it is required to design the four corners of the tile into non-rectangular and other shapes, the length and width may be measured from the distance between the side of the front projection of the sample and the intersection point of the extension lines from both ends (SEE Figure A1);

2) When the front projection of the concrete tile is not rectangular, it shall respectively measure the length of each edge, AND use the absolute value of the maximum deviation from its corresponding design dimension as the detection result.

A3.3 Squareness and hanging length

HANG the sample on the roof batten at the angle within 20° ~ 70°. MEASURE the length l_1 and l_2 from the upper edge of the vertical roof battens at both sides of the sample to the same front end (SEE Figure A2); USE the absolute value of the length difference as the detection result of the squareness, rounded off to 1 mm; USE the arithmetic mean of them as the detection result of the hanging length, rounded off to 1 mm.

Note: If the geometric shape of the front projection of the sample is non-rectangular, there is no squareness requirement.

A3.4 Flatness

PLACE the sample face up on a reference plane and MAKE it at stable state. USE the feeler to measure the clearance between the certain contact point of the sample and the reference plane (SEE Figure A3); RECORD the maximum value as the detection result, rounded off to 1 mm.

Appendix B

(Normative)

Bearing capacity test method

B1 Instrument and equipment

B1.1 Bending test machine

The measurement range of the bending test machine is 0 kN ~ 10 kN, the minimum scale value is not less than 20 N, the loading press stroke is greater than 500 mm, AND it has the stepless speed regulation function, with the accuracy of 1%.

B1.2 Measuring gauge

Steel ruler: range 0 mm ~ 500 mm AND scale value 1 mm.

B1.3 Water tank

Water tank: with a depth of about 500 mm which can immerse the sample.

B2 Sample humidity conditioning

IMMERSE the sample into the clean water of the temperature of 10 °C ~ 30 °C for at least 24 h; MAKE the water level be higher above the sample for 20 mm; WIPE the sample surface water before the test to prepare for use.

B3 Test procedures

B3.1 Measurement of tile ridge height

From both ends of the sample, MEASURE the tile ridge height, as shown in Figure B1. TAKE the arithmetic mean of the two as the measurement result, rounded off to 1 mm.

B3.2 Measurement of covering width

OVERLAP and PLACE horizontally the two samples based on the design functions, as shown in Figure B1 (b). From the both ends of the sample, MEASURE the covering width; TAKE the arithmetic mean of the two values as the measurement result, rounded off to 1 mm.

B3.3 Support method

USE the three-point bending method. USE two metal supports of same height, with its supper surface in circular arc AND the radius of 10 mm; it may place a hard wooden batten of width 20 mm, thickness 20 mm ~ 30 mm, and length more than sample width on the support; AND the lower surface of the wood batten shall be fitted to the upper surface of the support. In between the bottom surface of the sample and the wood batten, it shall place an elastic cushion.

The two supports shall be parallel to each other AND the vertical plane corresponding to the longitudinal axis of the sample must be freely adjustable. The center distance of the support is 2/3 l, which is taken as integer (mm), as shown in Figure B2.

B3.4 Sample placement

PLACE the sample face up on the support (SEE Figure B3); ENSURE the sample is stable AND the sample end surface is parallel with the support.

B3.5 Loading method

a) The load bar is the same as the support in material and dimensions, its lower surface is in circular arc, AND the radius is 10 mm. The load bar shall be parallel with the support AND be freely adjustable as relative to the vertical plane of the longitudinal axis of the sample;

b) The loader shall be located in the center of the span AND be kept parallel with the support;

c) In between the load bar and the sample, PLACE a hardwood balance that matches with the shape within the covering width range of the sample upper surface; it shall place an elastic cushion between the sample surface and the balance.

d) APPLY load through the load bar at the direction perpendicular to the sample plane with the maximum loading speed of 5000 N/min, until the sample fractures and damages.

Note: B3.3 elastic cushion length is greater than the width of the sample; B3.5 c the elastic cushion length shall be in line with the covering width of the sample, with its width of 20 mm ~ 30 mm, thickness of 5 mm ± 1 mm, AND Shore hardness (50 ± 10).

B3.6 Records

RECORD the maximum load as the sample bearing capacity, accurate to 10 N.

Appendix C

(Normative)

Test method for thermal resistance and water absorption

C1 Instrument and equipment

a) Drying oven: drying oven with blasting and moisture elimination function. The temperature range is 0 °C ~ 200 °C AND the temperature fluctuation range is ± 2 °C.

b) Electronic scales or balance: weighing 10 kg AND precision 5 g.

c) Water tank: same as the requirements of B1.3.

C2 Test procedures

C2.1 Sample

SELECT the big half from each of the 5 samples which are subjected to bearing capacity test as the sample for the thermal resistance and water absorption test.

C2.2 Immersion

After removing the dust from the surface of the sample and the loosening particles from the cross section, IMMERSE the sample in clean water of 10 °C to 25 °C for 24 h. During the test, MAKE the water level be higher above the sample for 20 mm, and ENSURE that each face of the sample sufficiently contact with water.

C2.3 Saturated mass

TAKE the sample out; USE wet towel twisted dry to remove the water attached to the surface; immediately WEIGH the saturated mass of each sample (m_b).

C2.4 Dry mass

After weighing the saturated mass, PLACE the sample in a well-ventilated environment of temperature 15 °C ~ 30 °C AND air relative humidity of not less than 40%; STORE it for 24 h.

PLACE the sample into the oven, in which the temperature is kept at 105 °C ± 5 °C, to dry it for 24 h. After the sample is removed, OBSERVE whether the surface coating is complete; if the sample surface coating is complete, COOL it down and WEIGH the sample mass. PLACE the sample into the oven again; MEASURE the sample dry mass once every 2 h, until the mass difference of the consecutive two measurements is less than 10 g, USE the result as the dry mass (m_0) of this sample.

If the sample surface has such defects as coating peeling, swelling, blistering, or pitting, TERMINATE the test. RE-SELECT the sample; appropriately REDUCE the temperature in the oven for 10 °C; ENSURE that the sample surface coating is complete; CONDUCT the water absorption test again.

Note: The samples used for the thermal resistance and water absorption re-test are 5 pieces of complete samples.

C3 Assessment and calculation

C3.1 Thermal resistance

After the samples are immersed in clean water at 10 °C ~ 25 °C for 24 h, STORE it in a well-ventilated environment of the temperature 15 °C ~ 30 °C AND air relative humidity of not less than 40% for 24 h. PLACE the sample into the drying oven; MAINTAIN the temperature in the oven at 105 °C ± 5 °C; DRY it for 24 h; AND those with complete surface coating are deemed as qualified; otherwise it will be deemed as disqualified.

C3.2 Water absorption

C3.2.1 Calculation

The water absorption of each sample is calculated in accordance with the equation (C1):

$$W = \frac{m_b - m_0}{m_0} \times 100 \quad \cdots\cdots (C1)$$

Where:

W - Water absorption, %;

m_b - Saturated mass of sample, in grams (g);

m_0 - Dry mass of sample, in grams (g);

C3.2.2 Assessment

Appendix D

(Normative)

Test method for impermeability

D1 Equipment

The impermeable frame appropriate to the specification of the sample under test.

D2 Sample humidity conditioning

STORE the sample in a well-ventilated environment of the temperature 15 °C ~ 30 °C AND air relative humidity of not less than 40% for at least 24 h.

D3 Test procedures

D3.1 PLACE the sample face up in the corresponding impermeable frame, with the deviation angle between the sample plane and the horizontal plane not greater than 10°.

D3.2 The clearance between the edge of the frame and the periphery of the sample shall be no more than 3 mm. USE the impermeable material to seal the clearance between the sample and the frame as well as the roofage tile fixation holes (SEE Figure D1).

D3.3 INJECT water into the test container formed with the sample as bottom which is sealed by the frame, to make the water level be higher above the tile ridge for 15 mm; during the test, MAINTAIN this height. STORE this test device in a well-ventilated environment of the temperature 15 °C ~ 30 °C AND the air relative humidity of not less than 40% for 24 h.

D4 Results and assessment

OBSERVE the back of the test sample to see if there is water droplet; if not, its impermeability is qualified. If in this group, there is one or more sample back appears water droplets, it means that the impermeability is disqualified.

Appendix E

(Normative)

Test method for frost resistance

E1 Instrument and equipment

E1.1 Cryostat or freezer

After placing the sample into the cryostat or freezer, the inside temperature shall be reduced to and maintained at a range of -15 °C ~ -20 °C. It is preferable for the air temperature in the cryostat or freezer to be reduced to below -15 °C within 90 min ± 30 min.

E1.2 Water tank

It is same as the requirements of B1.3.

E1.3 Sample rack

The sample rack shall be such that the interval between the samples is not less than 10 mm. The distance between the sample and the inner wall of the cryostat or freezer is not less than 20 mm.

E1.4 Bending test machine

It is same as the requirements of B1.1.

E2 Sample

IMMERSE 3 pieces of samples into the clean water of 15 °C ~ 30 °C for 24 h; TAKE it out before the test; MAKE the water attached to the sample surface drop freely.

E3 Test procedures

E3.1 PLACE the sample saturated in water on the sample rack; and then immediately PLACE it into the cryostat or freezer which is pre-reduced to the temperature of -15 °C ~ -20 °C.

E3.2 When the cryostat or freezer inside temperature is reduced to below -15 °C again, START timekeeping. MAKE it at this temperature for 2 h. Then

TAKE the sample out and immediately PLACE it in the water of 15 °C ~ 30 °C to thaw it for 1 h. This forms a freeze-thaw cycle.

The interruption of the freeze-thaw cycle can only occur in the thawing phase, AND the sample shall be immersed in water until the test continues, with the interruption time of not more than 96 h; AND if the interruption time is more than 24 h, corresponding descriptions shall be made.

E3.3 After 25 freeze-thaw cycles, PLACE the sample in an environment of the temperature 15 °C ~ 30 °C AND the air relative humidity of not less than 40% for 24 h. After the frozen sample pass the appearance quality inspection, FOLLOW the provisions of Appendix B to conduct the bearing capacity test.

E4 Calculation and assessment

E4.1 Calculation

In accordance with the equation (E1), CALCULATE the measured average of the bearing capacity of the sample after 25 freeze-thaw cycles. USE the equation (E2) to calculate the bearing capacity of the sample after 25 freeze-thaw cycles.

$$F_{avf} = \frac{F_{1f} + F_{2f} + F_{3f}}{3} \quad \text{(E1)}$$

$$F_f = F_{avf} - 1.64\sigma \quad \text{(E2)}$$

Where:

F_{avf} - The measured average of the bearing capacity after freezing, in the unit of Newton (N);

F_{1f}, F_{2f}, F_{3f} - The measured value of the bearing capacity of each sample after freezing, in the unit of Newton (N);

σ - Standard deviation of bearing capacity, in the unit of Newton (N);

F_f - Bearing capacity after freezing, in the unit of Newton (N);

E4.2 Assessment

After the freeze-thaw test, the bearing capacity of the sample under test is still not less than the standard value of the bearing capacity, that is, if $F_f \geq F_c$ AND the appearance quality is still in line with the requirements of Clause 6.1, the frost resistance is qualified; if one item is disqualified, the frost resistance is disqualified.

7	Anti-permeability		-	Tile back shall not have water droplet	Tile back is dry	Qualified
8	Frost resistance	Bearing capacity after freezing (F_f)	N	≥ 1800	2580	Qualified
		Appearance quality	-	Comply with this standard after freezing	Appearance quality is complete	Qualified
Note	The measured average mass (m_{av}) is 4280 g.					

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