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**Test method of air permeability, watertightness, wind load
resistance performance for building skylight system**

建筑采光顶 气密、水密、抗风压性能检测方法

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Test method of air permeability, watertightness, wind load resistance performance for building skylight system

1 Scope

This Standard specifies the terms and definitions, tests and test reports for test methods of air permeability, watertightness, wind load resistance performance for building skylight system.

This Standard is suitable for testing air permeability, watertightness, and wind load resistance performance for building skylight system. The test objects are limited to the building skylight system test piece itself and its connection structure with other structures, excluding structural embedded parts and fixed supports of the main structure.

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.

GB 50178, *Standard of climatic regionalization for architecture*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 building skylight

A building envelope composed of translucent panels and a supporting system that does not share the effects of the main structure and has an angle of less than 75° with the horizontal direction.

3.2 standard condition

The test conditions are that the air temperature is 293 K (20°C), the atmospheric pressure is 101.3 kPa (760 mm Hg), and the air density is 1.202 kg/m³.

3.3 pressure difference

The absolute air pressure difference between the indoor and outdoor surfaces of the test piece. When the pressure on the outdoor surface is higher than the pressure on the

indoor surface, the pressure difference is positive; otherwise, it is negative.

3.4 air permeability performance

The ability of the test piece to prevent air penetration.

3.4.1 volume of extraneous air leakage

In addition to the air penetration of the test piece itself, the amount of air passing through the equipment and the connection between the test piece and the pressure box per unit time.

3.4.2 total volume of air leakage

The sum of the air penetration amount and volume of extraneous air leakage passing through the test piece per unit time.

3.4.3 operable joint length

The total length of the indoor inner joints that can be opened on the test piece.

3.4.4 volume of air leakage per unit of operable joint length

Under the standard condition, the amount of air passing through the unit operable joint length of the test piece per unit time.

3.4.5 area of test piece

The surface area included in the gap between the test piece periphery and the box seal. It is based on the indoor measurement.

3.4.6 volume of air leakage per unit of area

Under the standard condition, the amount of air passing through unit area of the test piece per unit time.

3.5 watertightness performance

The ability of the test piece to prevent rainwater from leaking into the room under the simultaneous action of wind and rain.

3.5.1 water leakage

The phenomenon of rainwater continuously or repeatedly penetrating into the inside of the test piece and dripping from the outside of the test piece.

3.5.2 water spray rate

The amount of water sprayed onto the outdoor surface of the unit area of the test piece

Keys:

- a - pressure box;
- b - differential pressure gauge;
- c - water flow meter;
- d - water spray device;
- e - displacement meter;
- f - test piece;
- g - installation horizontal frame;
- h - air inlet baffle;
- i - air flow meter;
- j - pressure control device;
- k - pressure supply equipment;
- θ - angle between the test piece and the horizontal plane.

Figure 1 -- Schematic diagram of the testing device

4.1.2 The opening size of the pressure box shall be able to meet the requirements for the installation of the test piece. The pressure box shall be suitable for personnel to enter to install the test piece or observe. The box shall have good watertightness performance. The minimum requirement is to not affect the watertightness of the observed test piece. The box shall be able to withstand the pressure difference that may occur during the testing process.

4.1.3 The test piece installation system is used to fix the test piece and seal the test piece with the opening of the pressure box. It shall have sufficient stiffness and strength to not have a significant impact on the test results.

4.1.4 The pressure supply system shall be able to exert a positive and negative two-way pressure difference and reach the maximum pressure difference required for testing. The pressure control device shall be able to regulate a stable air flow. It can stably provide fluctuating wind pressure with a period of 3 s ~ 5 s. The peak and trough values of fluctuating wind pressure shall meet the testing requirements.

4.1.5 Test pieces of point support structures shall have independent installation frames. Under the action of the maximum testing pressure difference, the deformation of the mounting frame shall not affect the performance of the test piece.

4.1.6 The two testing points of the differential pressure gauge shall be arranged nearby on both sides of the test piece. The error of the differential pressure gauge shall be less than 1% of the indicated value. The response speed shall meet the requirements of fluctuating wind pressure measurement. The output signal of the differential pressure gauge shall be recorded by a chart recorder or a device that displays changes in pressure.

4.1.7 The measurement error of the air flow measuring device shall be less than 5% of the indicated value.

4.1.8 The spray device shall be able to spray evenly onto the outdoor surface of the test

piece with a spray volume of no less than 4 L/(m²·min). It shall be able to form a continuous and complete water film on the surface of the test piece. The nozzles shall be evenly spaced. The distance between each nozzle and the test piece shall be equal. The water spray volume of the device shall be adjustable. There are measures to ensure the uniformity of water spray volume.

4.1.9 The measurement error of the water flow meter shall be less than 5% of the indicated value.

4.1.10 The accuracy of the displacement meter shall reach 0.25% of full scale. The mounting bracket of the displacement meter shall have sufficient tightness during the test. It shall be ensured that the displacement measurement is not affected by the deformation and movement of the test piece and its supporting facilities.

4.1.11 A safety net shall be installed at the bottom of the test piece or other safety measures shall be taken. Safety measures shall also be taken around the test piece when necessary.

4.2 Requirements for test piece

4.2.1 The material, specification and model of the test piece shall be consistent with the drawings provided by the testing client. No special accessories or measures other than those designed are allowed. The angle between the test piece and the horizontal plane shall be consistent with the actual engineering conditions or product design. The installation of the test piece shall comply with the design requirements. The test pieces shall be dry.

4.2.2 The stress conditions during assembly and installation of the test piece shall be consistent with the actual situation.

4.2.3 The test piece shall include all typical seams.

4.2.4 If the skylight is designed with an openable part, the openable part shall be included when selecting the test piece.

4.2.5 If there is a drainage ditch design on the inside of the skylight, the drainage ditch shall be included when selecting the test piece.

4.2.6 Point-supported skylight test pieces shall meet the following requirements:

- a) The support structure shall have at least one typical load-bearing unit.
- b) The support structure of the tension cable-bar system shall be tested according to the actual support span. The pretension force shall be consistent with the design. The tension cable rod system shall test the pretension of the cable.
- c) When the support span is greater than 15 m, the performance test of the glass and its support devices and the structural static test of the support structure can be

4.4.2.3 Preparing for pressurization

Three pressure pulses are applied before positive and negative pressure testing. The absolute value of the pressure difference is 500 Pa. The duration is 3 s. The pressurization speed shall be 100 Pa/s. Then start testing after the pressure returns to zero.

4.4.2.4 Testing of penetration amount

4.4.2.4.1 Determination of volume of extraneous air leakage q_f

Adequately seal the gaps on the test piece. Or seal the opening of the box with airtight material. Then pressurize step by step according to Figure 2. The pressure action time of each level shall be greater than 10 s. First add positive pressure step by step. Then add negative pressure step by step. Record the testing values at all levels. The volume of extraneous air leakage of the box shall not be higher than 20% of the total penetration of the test piece, otherwise the test shall be re-tested after treatment.

4.4.2.4.2 Determination of the sum of volume of extraneous air leakage and the volume of air leakage of fixed part q_{fg}

The opening gap of the openable part on the test piece is sealed before testing. The testing procedure is the same as 4.4.2.4.1.

4.4.2.4.3 Determination of total volume of air leakage q_z

Test after removing the sealing measures added to the test piece. The testing procedure is the same as 4.4.2.4.1.

NOTE: It is allowed to adjust the testing sequence of 4.4.2.4.2 and 4.4.2.4.3.

4.4.3 Processing of testing values

4.4.3.1 Calculation

Calculate as follows:

- a) Calculate the average value $\overline{q_f}$ of the testing values of two volumes of extraneous leakage under the action of 100 Pa pressure difference during the positive pressure testing process of pressure increase and pressure reduction, and the average testing value of the sum of the two volumes of extraneous air leakage and the volume of air leakage of the fixed part $\overline{q_{fg}}$, the average value of two total volumes of air leakage $\overline{q_z}$. According to formula (1) ~ formula (3), it is converted into the standard condition:

time of the test piece without openable parts lasts for 40 min or until leakage occurs;

- d) Observation and recording: during the process of increasing pressure and continuing action, observe and record the leakage situation and location.

4.5.5 Assessment of test results

If no leakage occurs, it is determined that the entrustment requirements are met, otherwise it is determined that the entrustment requirements are not met. The results of the first watertightness performance test and repeated watertightness performance tests are determined based on this.

4.6 Wind load resistance

4.6.1 Testing index

The standard value of wind load required by the commission is used as the testing index P_3 .

4.6.2 Testing item

Test whether the deformation of the test piece meets the commissioned requirements under the action of wind pressure, and whether the test piece has structural damage or functional impairment, including: deformation testing, repeated pressure testing, wind load standard value testing.

4.6.3 Testing method

4.6.3.1 Preparation before testing

4.6.3.1.1 Select the measuring point to install the displacement measuring instrument. Displacement measuring instruments shall be installed at the maximum displacement and near the support point. Specific requirements for measuring point layout include:

- a) See Figure 5 for the layout of rod measuring points. The distance between the displacement measurement points at both ends and the adjacent support points shall not be greater than 10 mm;
- b) When there is more than one main force-bearing rod, they can be tested separately. The one with the larger relative deformation is used for result assessment;
- c) The layout of measuring points of force-bearing components of other types of test pieces shall be determined according to the commissioning requirements;
- d) Measuring points for special components shall be arranged according to the mechanical model of the component. The finite element method shall be used to determine if necessary;

a_0, b_0, c_0 - the stable initial readings of the measuring points at each corner of the triangle after preliminary pressurization, in millimeters (mm);

a, b, c - the readings of the measuring points at each corner of the triangle under the action of a certain level of testing pressure, in millimeters (mm).

4.6.4.1.2 The deflection of other components is calculated according to formula (11):

$$f_{\max} = (b - b_0) - \frac{(a - a_0) + (c - c_0)}{2} \dots\dots\dots (11)$$

Where,

$f_{\max}$ - the frontal deflection, in millimeters (mm);

a_0, b_0, c_0 - the stable initial reading of each measuring point after preliminary pressurization, in millimeters (mm);

a, b, c - the reading of each measuring point under a certain level of testing pressure, in millimeters (mm).

4.6.4.2 Assessment

4.6.4.2.1 Assessment of deformation testing

There shall be no functional impairment or damage to the test piece, otherwise it shall be judged as not meeting the commissioned requirements.

4.6.4.2.2 Assessment of repeated pressurization test

There shall be no functional impairment or damage to the test piece, otherwise it shall be judged as not meeting the commissioned requirements.

4.6.4.2.3 Assessment for testing of wind load standard value

If the relative frontal deflection of the stressed component is less than or equal to the allowable relative frontal deflection f_0 , and there is no dysfunction or damage during or after the test, it shall be judged to meet the commission requirements.

4.7 Repeated air permeability performance

According to the inspection entrusted index of repeated air permeability performance, proceed in accordance with 4.4.

4.8 Repeated watertightness performance

According to the inspection entrusted index of repeated watertightness performance, proceed in accordance with 4.5.

4.9 Wind load resistance (wind load design value testing)

4.9.1 Testing indicators

$P_{\max}$ is 1.4 times the testing index P_3 .

4.9.2 Testing item

Test whether the test piece has structural damage or functional impairment under the action of $P_{\max}$.

4.9.3 Testing method

The testing pressure rises to $P_{\max}$. The pressurization time is no less than 3 s. Then it drops to zero. Then drop to $-P_{\max}$. The pressurization time is no less than 3 s. Then it goes up to zero. Document the condition and location of dysfunction or damage.

4.9.4 Assessment

Assess according to commission requirements.

5 Testing report

The testing report shall include the following content:

- a) Project name, project location, client name, and construction party name;
- b) Name, main dimensions and drawings of the test piece (including the facade, section and main nodes of the test piece, the sections of profiles and sealing strips, the drainage structure and the location of the drainage holes, the support system of the test piece, the dimensions of the main stress-bearing components and the opening method of the openable part and the type, quantity and position of the hardware), the angle between the test piece and the horizontal plane;
- c) Commissioned testing items, testing indicators, and deflection requirements;
- d) Manufacturer, specifications and span of rods and cables;
- e) Panel manufacturer, type, thickness, maximum size and installation method;
- f) Manufacturer, material and designation of sealing material;
- g) Manufacturer, name, material and configuration of accessories;
- h) Design value and actual measured value of cable pre-tension force for point-supported structural test pieces;
- i) Main instruments and equipment used for testing;

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