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**Method of test for hygroscopic sorption
properties of building materials**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Testing Center for Construction Materials (JTCCM)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS A 1475:2004**), which has been technically revised.

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Method of test for hygroscopic sorption properties of building materials

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 12571** : 2013, Edition 2, with some modifications of the technical contents to incorporate conditions of the tests conducted in Japan.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JC. Annex JA and JB are unique to **JIS** and not given in the corresponding International Standard. The comparison table between previous and current editions of this Standard on technically significant revisions is given in Annex JD.

1 Scope

This Standard specifies the method of test for hygroscopic sorption properties of building materials.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 12571 : 2013 *Hygrothermal performance of building materials and products — Determination of hygroscopic sorption properties* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS A 0202 *Thermal insulation — Vocabulary*

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 9346 *Hygrothermal performance of buildings and building materials — Physical quantities for mass transfer — Vocabulary* (MOD)

JIS A 1476 *Measuring method for moisture content of building materials by drying at elevated temperature*

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 12570 *Hygrothermal performance of building materials and prod-*

ucts — Determination of moisture content by drying at elevated temperature (MOD)

3 Terms and definitions, symbols and units

3.1 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS A 0202**, and the following apply.

3.1.1

moisture absorption

transfer of water vapour from ambient air to a porous building material (hereafter referred to as material) up to the point of equilibrium

3.1.2

moisture desorption

transfer of water vapour from a porous building material to ambient air up to the point of equilibrium

3.1.3

equilibrium moisture content

ratio of mass or volume of evaporable water in a porous material that has reached equilibrium with the ambient air after absorbing and/or releasing water vapour from/into the ambient air to the mass or volume of the material in reference drying state

The mass ratio is called the **moisture content mass by mass**, and the volume ratio, the **moisture content volume by volume**.

3.1.4

reference drying

drying of a material without changing it, i.e. drying at $105\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ (for a material not changing its structure at $105\text{ }^{\circ}\text{C}$), $65\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ (for a material changing its structure at $65\text{ }^{\circ}\text{C}$ to $105\text{ }^{\circ}\text{C}$), and $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ (for a material changing its characteristics at $40\text{ }^{\circ}\text{C}$ or higher due to diffusion of crystal water or gas), performed in accordance with **JIS A 1476**

3.1.5

equilibrium moisture content curve

curve that establishes the relationship between the equilibrium moisture content of a material and the relative humidity of the ambient air, at a given temperature

This curve is constructed either for moisture-absorption process or moisture-desorption process, the former being called the **sorption curve** and the latter, **desorption curve**.

3.2 Symbols and units

The symbols and units shall be as given in Table 1.

Table 1 Symbols and units

Symbol	Designation	Unit
u	Moisture content mass by mass	kg/kg
ψ	Moisture content volume by volume	m ³ /m ³
m	Mass of test specimen	kg
m_0	Mass of test specimen in reference drying state	kg
V_0	Volume of test specimen in reference drying state	m ³
ρ_0	Density of test specimen in reference drying state	kg/m ³
ρ_w	Density of water	kg/m ³
ϕ	Relative humidity	%

4 Measurement principle

The specimen is placed in an environment of specific relative humidity and temperature produced by either of the following two methods, and the mass of the test specimen when it has reached equilibrium with the environment after absorbing and/or releasing moisture from/into the environment is measured. The equilibrium moisture content is determined as a ratio of this measured mass to the mass or volume of the test specimen in reference drying state.

- Method by the saturated salt solution contained in a container made of glass or other material (desiccator method).
- Method by an automatic chamber such as a climatic chamber (climatic chamber method).

In the desiccator method and the climatic chamber method, the test specimen goes through moisture-absorption process and moisture-desorption process, the former being a process where the specimen is initially brought to a reference drying state and then allowed to absorb water vapour from the ambient air, and the latter being a process where the specimen is initially brought to a wet state and then allowed to desorb water vapour into the ambient air.

Measurements are made at a minimum of five appropriately spaced relative humidities selected in the range of 0 % to 100 %, and equilibrium moisture content measured at each of the selected humidities is plotted to obtain sorption and desorption curves.

5 Apparatus

5.1 Desiccator method

The test apparatus shall consist of constant-temperature room, constant-humidity container (desiccator), balance, and temperature-measuring instrument.

5.1.1 Constant-temperature room, capable of maintaining the specified test temperature (23 °C) to an accuracy of ± 0.5 K or better.

5.1.2 Constant-humidity container (desiccator), satisfying the following.

- a) It shall be made of glass or other material that is moisture impermeable and corrosion-resistant, and provided with a base suitable for containing saturated salt solution.
- b) It shall be capable of maintaining the relative humidity to an accuracy of ± 2 % relative humidity.

NOTE..... See Annex JA for examples of different constant-humidity containers (desiccators).

5.1.3 Balance, capable of weighing to the nearest 1 mg, or to an accuracy of ± 0.01 % of the mass of the test specimen, whichever is the better accuracy.

The weighing accuracy can be determined with respect to the total mass (mass of the test specimen and the weighing cup) and the required accuracy of the test results.

5.1.4 Temperature-measuring instrument, capable of measuring the temperature to an accuracy of ± 0.1 K.

5.2 Climatic chamber method

The test apparatus shall consist of climatic chamber, balance, temperature-measuring instrument, and humidity-measuring instrument.

NOTE..... See Annex JB for examples of climatic chambers.

5.2.1 Climatic chamber, capable of maintaining the relative humidity within ± 3 % relative humidity, and the temperature within ± 0.5 K. The temperature shall be set to 23 °C.

5.2.2 Balance, specified in 5.1.3

5.2.3 Temperature-measuring instrument, specified in 5.1.4.

5.2.4 Humidity-measuring instrument, capable of measuring the relative humidity to an accuracy of ± 3 % relative humidity.

6 Test specimens

6.1 Specimen size

A test specimen shall be representative of the material being tested and have a mass of at least 10 g. If it can be demonstrated that the result will not be affected, a smaller specimen size may be used to reduce the time to reach equilibrium, in which case the mass of the specimen shall be such that the required weighing accuracy is still met.

6.2 Number of test specimens

Three test specimens taken from the same material shall be tested. For a material with minimum variation among specimens for which tests at several relative humidity levels are conducted simultaneously, three specimens representative of the material shall be taken for testing at each of the relative humidity levels.

6.3 Density of test specimen

The density of test specimen shall be determined from the mass and volume of the test specimen in reference drying state according to Formula (1) :

$$\rho_0 = \frac{m_0}{V_0} \dots\dots\dots (1)$$

where, ρ_0 : density of test specimen in reference drying state (kg/m³)
 m_0 : mass of test specimen in reference drying state (kg)
 V_0 : volume of test specimen in reference drying state (m³)

7 Procedure

7.1 Test conditions

Testing shall be conducted at 23 °C ± 0.5 °C in principle.

If agreed between the interested parties, other temperatures may be applied to suit specific applications.

7.2 Relative humidity setting of container for desiccator method

The relative humidity setting of constant-humidity container shall be as follows.

- a) Use appropriate saturated salt solution to achieve the necessary relative humidity in the container. Choose five or more salts from Table 2, always including No. 2, No. 4, and No. 6.

NOTE Annex A gives the air relative humidities of various saturated salt solutions.

Table 2 Typically used salts

No.	Substance	Relative humidity (%)
1	ZnCl ₂ ·xH ₂ O	10
2	MgCl ₂ ·6H ₂ O	33
3	Mg(NO ₃) ₂ ·6H ₂ O	53
4	NaCl	75
5	KCl	85
6	KNO ₃	93
NOTE Relative humidities in the table correspond to air temperature 23 °C.		

- b) The depth of saturated salt solution under coexistence of crystal shall be 30 mm to 50 mm.

NOTE Annex B describes the preparation of various solutions.

- c) Place the container in the constant-temperature room controlled to the specified test temperature.
- d) Measure the air temperature of the constant-temperature room.

7.3 Relative humidity setting for climatic chamber method

Select a minimum of five relative humidities in the range of 20 % to 93 % according to the humidity setting of the desiccator method.

Other humidity setting may be used for cases where the lowest humidity level below 20 % is selectable.

7.4 Procedure

7.4.1 General

The equilibrium moisture content measurement procedures of absorption process and desorption process are as described in 7.4.2 and 7.4.3, respectively.

Where tests at two or more relative humidity levels are conducted simultaneously in order to reduce test time, prepare as many test specimens, and constant-humidity containers or climatic chambers as the number of levels to be tested, and perform test at each level of relative humidity. This way of testing is only applicable to materials where variation among test specimens is expected to be of a minimum degree.

NOTE For materials expected to have large variation (e.g. materials that are non-uniform in quality due to the manufacturing process etc., or natural materials), this decision should be made by agreement between the interested parties.

7.4.2 Absorption process

The procedure for equilibrium moisture content measurement by absorption process shall be as follows.

- a) Dry the test specimen at the temperature specified for reference drying until constant mass is attained, and weigh the specimen. Note this mass as the mass of test specimen in reference drying state, m_0 .

Constant mass is reached if the change of mass between three consecutive weighings, each made at least 24 h apart, differs by not more than 0.1 % of the total mass. Calculate the mass change according to Formula (2), and take the mass of the last weighing as the mass of the test specimen in reference drying state, m_0 .

$$\Delta m_d = \left| \frac{m_n - m_{n+1}}{m_{n+1}} \right| \times 100 \quad \dots\dots\dots (2)$$

where, Δm_d : mass change (%)
 m_n : mass of test specimen at n^{th} measurement (kg)
 m_{n+1} : mass of test specimen at $(n + 1)^{\text{th}}$ measurement (kg)

- b) In desiccator method, dry the test specimen under the reference drying condition, and as soon as it has reached constant mass, put it in the constant-humidity container controlled to the lowest relative humidity of the range of values chosen for the test, and periodically weigh it until it has reached constant mass (Level 1). As soon as constant mass is recognized at Level 1, put the specimen in a constant-humidity container controlled to the second lowest humidity, and perform the same measurement (Level 2). Repeat the procedure for five or more humidity levels in increasing order.

Constant mass is reached if the change of mass between three consecutive weighings, each made at least 24 h apart, differs by not more than 0.1 % of the total mass. Calculate the mass change according to Formula (3), and take the mass of the last weighing as the mass of the test specimen at constant mass.

$$\Delta m_d = \left| \frac{m_n - m_{n+1}}{m_0} \right| \times 100 \quad \dots\dots\dots (3)$$

where, Δm_d : mass change (%)
 m_0 : mass of test specimen in reference drying state (kg)
 m_n : mass of test specimen at n^{th} measurement (kg)
 m_{n+1} : mass of test specimen at $(n + 1)^{\text{th}}$ measurement (kg)

- c) In climatic chamber method, dry the test specimen under the reference drying condition, and as soon as it has reached constant mass, put it in the climatic chamber controlled to the lowest relative humidity of the range of values chosen for the test, and periodically weigh it until it has reached constant mass (Level 1). Then perform the same measurement with the relative humidity increased to the next level (Level 2). Repeat the procedure for five or more humidity levels in increasing order.

Constant mass is reached if the change of mass between three consecutive weighings, each made at least 24 h apart, differs by not more than 0.1 % of the total mass. Calculate the mass change according to Formula (3), and take the mass of the last weighing as the mass of the test specimen at constant mass.

7.4.3 Desorption process

The procedure for equilibrium moisture content measurement by desorption process shall be as follows.

- a) Put the test specimen in an atmosphere of not less than 95 % relative humidity to allow it to absorb moisture until constant mass is reached.

NOTE Starting the absorption procedure at a higher temperature than the measuring temperature and then lowering it to the measuring temperature will accelerate the saturation process.

- b) In desiccator method, place the test specimen in a constant-humidity container controlled to the highest relative humidity (Level 5 or more) of the range of values chosen for the test until it has reached constant mass. Constant mass is reached if the change of mass between three consecutive weighings, each made at least 24 h apart, differs by not more than 0.1 % of the total mass. Change of mass is calculated according to Formula (2). Then put the test specimen in a constant-humidity container controlled to the second highest relative humidity level, and perform the same measurement. Repeat the procedure for the chosen values of humidities in decreasing order down to the lowest level (Level 1).
- c) In climatic chamber method, perform measurement in a chamber controlled to relative humidity of 93 % (Level 5 or more) until the test specimen has attained constant mass. Constant mass is reached if the change of mass between three consecutive weighings, each made at least 24 h apart, differs by not more than 0.1 % of the