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Diagnosing moisture damage in buildings and implementing countermeasures —

Part 2:
Assessment of conditions

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Foreword

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This document was prepared by Technical Committee ISO/TC 205, *Building environment design.*

A list of all parts in the ISO 22185 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The term "moisture damage" is interpreted in many ways. Cognisance of moisture damage is not always consistent between specialists (e.g. engineers, researchers), residents and building users, leading to confusion. For example, residents and building users would consider the occurrence of condensation on window glass or on the surface of a metal sash to be a prime example of moisture damage, but considering the durability of glass and metal materials, it is not always appropriate to call that "moisture damage." However, supposing the condensation that occurs on the glass becomes the cause of an outbreak of mould on the curtains, it would be called moisture damage. It is imperative to resolve the confusion by defining "moisture damage" and by demonstrating the criteria for diagnosing whether an occurring phenomenon in a building is moisture damage or not.[1]

This document defines moisture damage in buildings and demonstrates criteria for diagnosing whether a phenomenon that occurs in a building is moisture damage or not, for a common understanding between residents, building users and specialists. It also demonstrates methods for the classification of moisture damage.

This document is the second part of the ISO 22185 series of standards on moisture damage. ISO 22185-3[1)] will show a framework for investigating and taking countermeasures against moisture damage.

1) Under preparation. Stage at the time of publication: ISO/PWI 22185-3.

Diagnosing moisture damage in buildings and implementing countermeasures —

Part 2: Assessment of conditions

1 Scope

This document describes methods for diagnosing and assessing conditions that can result in moisture damage impacting the building's energy and durability performance. For the purpose of classifying moisture damage, methods in this document range from basic observation techniques to more complex methods using equipment to more accurately or precisely render a condition assessment and provide data. This document does not ensure that the methods identified will result in the full disclosure of all moisture damage conditions.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Qualitative evaluation of moisture damage

4.1 Visual

4.1.1 Process of diagnosing moisture damage by site inspection

The procedures of diagnosing moisture damage by site inspection of existing buildings are explained in this clause. Although visual inspection plays a central role in the inspection, the final judgement is given by integrating all the information from physiological sensing including touching, smelling and hearing. Inquiry survey on clients, users, designers and builders is also essential in this respect. The content and procedures of the inspection depends on the kind of building (e.g. residential, office, factory, store).

In many cases, the procedures of an inspection are as follows:

a) Request for diagnosis of moisture damages, e.g. from owner, users, designer.

The client asks to diagnose a moisture problem and explains the details of the problems (e.g. kind of moisture damage, kind of building, when and where). The drawing and specification of the building may be referenced.

b) Site inspection: moisture damage or not?

Site inspection is the most important part and whether moisture damage really exists or not is judged with the help of the inquiry to the client (e.g. owner, user, designer). In this stage, the moisture damages described in ISO 22185-1:2021, Figures 2 and 3 are checked with respect to each building element, material, and room. The moisture damage (e.g. deformation, cracks, exfoliation, discoloration, wetting, mould growth, salting out and efflorescence) are identified by mainly visual inspection with the help of information obtained by the smell when entering the room (olfactory sensation), wetness of the wall (sense of touch), temperature of room and wall (thermal sensation), hammering test (sense of hearing). In this identification process, potential moisture source (e.g. rainwater, indoor and/or outdoor vapor, groundwater) and the resulting moisture damage are taken into consideration. Reference to the site plan, drawing and specification of the building, and the information from hearing about the usage of the rooms and environmental conditions are useful.

c) Estimate of causes for moisture damage

The cause(s) of the moisture damage is estimated taking into consideration these results comprehensively. In particular, the identification of the moisture source (e.g. indoor or outdoor vapor, leakage of rainwater, ground water, water leakage from piping) is important and not necessarily easy. In this process, ISO 22185-1:2021, Figures 2 and 3 can be utilized.

d) Second inspection and hearing if necessary

Second inspection and hearing can be required if any questions arise in c), or the cause of moisture damage was difficult to be identified, or inspection at another season is required.

e) Proposal of implementing countermeasures

The cause of the moisture damage is estimated and the countermeasures are proposed. The countermeasure is different depending on the difficulty of identifying the cause of the moisture damage, i.e. confirmation of whether the estimated cause seems valid, additional survey to identify the cause, analysis or laboratory experiment to identify complex and combined effects. In this stage, ISO 22185-1:2021, Clause 8 should also be taken into consideration.

4.1.2 Points of visual inspection

a) Objects of visual inspection

The objects of the visual inspection are classified by the inspection position (outside or inside), kind of room, building element (e.g. roof, wall, openings), and situation of moisture damage (ISO 22185-1:2021, Figures 2 and 3).

b) Inspection position: whole building, outside view, inside view.

c) Room: living room, kitchen, bedroom, bathroom, washroom, entrance, closet, corridor, staircase, crawl space, attic space, underground room.

d) Building element: roof, ceiling, external wall, partition wall, floor, foundation, groundsill, opening, building system (installation).

e) Situation of moisture damage: refer to ISO 22185-1:2021, Figures 2 and 3.

f) Change regarding colour characteristics: Hue, brightness, and chroma of the surface can change because of microorganisms (see ISO 16000-18), salt and/or efflorescence, rotting, discoloration by ultraviolet ray, water droplet or wetness.

4.2 Tactile

By touching the surface of the building components such as a wall or a floor, it is sometimes possible to detect the occurrence of a moisture damage. If wetness or cold is felt more strongly than the other parts around when touching the surface of the building components, then the occurrence of condensation or some kind of water immersion are suspected. If the surface texture conditions are different from the other parts around, the reason should be pursued; in some cases, moisture can be related to those phenomena.

NOTE Texture conditions can include roughness and softness.

4.3 Odour

If an unusual odour is detected in a building, the location of the odour should be identified and the cause of the odour should be clarified. Sometimes, this can be due to moisture. It is necessary to find out what causes dampness. At the same time, the possibility of odour generation due to chemical changes caused by moisture damage should also be kept in mind.

4.4 Sound

By hearing change in sounds when tapping surfaces, the existence of a cavity can be detected. When anomalous sounds are detected, the cause should be clarified. Deformation of building components will make noise. When the sound of moisture dripping in a cavity is detected, the source should be determined.

4.5 Occupant survey

Obtaining information from the occupants of buildings can identify areas of the building that are affected by moisture damage. The occupants can be aware of unusual conditions in the buildings, whether these conditions change during the year, and advise of issues that affect them. This information can identify moisture issues that are not readily apparent during site inspection.

For details, see ISO 21105-1.

NOTE Additional information can be found in ASTM E3026,[5] ASTM E2270,[6] ASTM-E2841.[7]

4.6 Risk assessment

Potential sources of moisture that can contribute to either the damage of the building or the building environment, or both, shall be assessed. Sources that are identified by the surveyor as latent sources of moisture damage shall be reported and included in the evaluation of the building.

5 Quantitative evaluation of moisture damage by measurement

5.1 Measuring relative humidity (RH) and temperature

An RH sensor measures the RH (and often the temperature as well) of air. When the RH exceeds the acceptable range for a long time, moisture damage is likely to occur. Some RH sensors can work independently with an integrated mini data logger, while others should be connected to an external data logger. In most cases, such sensors work reliably in the RH range of 20 % to 95 %. When the RH is extremely high or low, most RH sensors fail to provide accurate measurements.

5.2 Measuring capillary pressure by psychrometer and tensiometer

When the ambient humidity is extremely high, RH sensors are no longer reliable. Instead, psychrometers or tensiometers should be used. There are different types of psychrometers, such as transistor psychrometers and dew-point psychrometers. Transistor psychrometers work as dry-bulb/wet-bulb thermometers to detect the moisture potential, while dew-point psychrometers measure the dew-point of moist air through chilled mirror or other techniques. Tensiometers can be inserted into a moist material (e.g. soil) and measure its capillary pressure. All these sensors are very sensitive to temperature fluctuations and should be calibrated carefully. If the effect of temperature is neglected, as is often the case, capillary pressure is uniquely related to moisture content. As a physical property of the material, this relationship is expressed as a suction curve. For more details on capillary pressure measurements, see Annex A and ISO 11276.

5.3 Measuring moisture content by electrical resistance

In building materials (e.g. stone, concrete, and wood), the electrical conduction is essentially an electrolytical phenomenon linked to the fluid phase in porosity. For example, the resistivity of concrete can evolve between less than 100 Ωm (in the semiconductor range) when it is saturated, to 10^9 when it is dry (in the insulator range). The water volume influences the ability for ions to move through a porous network.

The electrical resistance of a material R (Ohm) is assessed by inducing a known electrical current I (A) between two electrodes and measuring the resulting difference of potential U (V) between two electrodes, following Ohm's law in Formula (1):

$$U = RI \tag{1}$$

There are several devices (methods) measuring electrical resistance. The two-plate-electrode method, the two-point electrode (or pin meter) method, and the four-probe electrode method are the typical devices. All these methods are done in the range of continuous current, or with low frequency alternative current (<300 Hz).

In the two-electrode method, the potential drop mainly corresponds to the electrical coupling at the contact between electrodes and material, i.e. 40 % of the total difference of potential at a distance is equal to two diameters from the electrode axis. Thus, the measurement is significantly influenced by the material properties in the vicinity of electrodes more than by properties in depth. The four-probe electrode method flows a current between two probes and measures the potential difference between two other electrodes, which allows a large surface to be covered and to increase the sensored depth. [9][10]

5.4 Measuring moisture content by electrical capacitance

Unlike many humidity sensors that measure the moisture potential in the air or in the material, an electrical capacitance meter measures the moisture content of a material directly. The electrical permittivity of water is often much higher than that of building materials, so the apparent electrical capacitance/permittivity of a moist building material is a function of its moisture content. With a calibrated curve for moisture content (e.g. electrical capacitance/permittivity), it is possible to obtain the moisture content of a specific building material by measuring its electrical capacitance/permittivity.

5.5 Measuring surface temperature by infrared camera

An infrared camera measures the surface temperature based on the radiative heat transfer. The distribution of surface temperature can be visually inspected. A thermal bridge usually displays a different colour from the well-insulated part. This can originate from poor thermal design, bad choice of insulation material, the wet part with a higher thermal conductivity, or air leakage.

5.6 Measuring mechanical properties by ultrasonic device to check the mechanical damage

An ultrasonic device can be used to check potential mechanical damage caused by moisture. The device emits and receives ultrasonic pulses, which travel within a solid target. By checking the time interval of the traveling pulse, mechanical characteristics (e.g. Young's modulus) can be obtained. When a material is very wet, the pulse travels faster than in a dry state. When there is a fissure in the pathway, the pulse travels more slowly than usual.

