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Diagnosing moisture damage in buildings and implementing countermeasures —

Part 1: Principles, nomenclature and moisture transport mechanisms

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 205, *Building environment design,* in collaboration with the Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment.*

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 (engineers, researchers, etc.) 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”. Then again, supposing the condensation that occurs on the glass becomes the cause of an outbreak of moulds on the curtains, that 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.

This document defines moisture damage in buildings and demonstrates criteria for diagnosing whether phenomena 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 first part of a series of standards on moisture damage. In the following parts, a framework for investigating and taking countermeasures against moisture damage, and design methods of building for reducing moisture damage will be shown.

The basic ideas of this document are derived from Reference [6].

Diagnosing moisture damage in buildings and implementing countermeasures —

Part 1: Principles, nomenclature and moisture transport mechanisms

1 Scope

This document defines moisture damage and it specifies the moisture sources and the moisture transport mechanisms in buildings.

It includes a method for classification of moisture damage based on the relation of:

— materials and constituent materials,

— phenomena, and

— functionalities that can be affected.

This document deals with:

1) building damage that is induced by (gaseous/liquid/solid) water, and

2) damage to building components, human health, and property contained in the enclosure. This document makes no mention of warranties for building damage.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

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

3.1
condensation damage
damage (3.3) caused by water vapour condensing on a material resulting in the material's deterioration and reduced performance which then affect human health

3.2
critical relative humidity
limit for a material to maintain acceptable function throughout the time the material is exposed to the moisture state

Note 1 to entry: Temperature, exposure time, dirt, combination with other materials and varying moisture conditions also affect, in a complicated manner.

Note 2 to entry: The critical moisture condition can be expressed either as a critical relative humidity (RH_{crit}) or as critical moisture content (w_{crit}).

3.3
damage
phenomena that affect the function/performance of the building (structural resistance/architectural/functional depression of components, functional depression and malfunction of building equipment, decrease in value of property), aesthetics and that cause a deterioration in the living environment of the building, including human health

3.4
frost damage
damage (3.3) including surface cracks, peeling/exfoliation/delamination caused by the repeated freezing/thawing of moisture inside the materials or on a surface between a material and freezing water

3.5
moisture content
moisture mass per unit mass of dry materials, or moisture mass or volume per unit volume of materials

Note 1 to entry: Depending on the standard physical quantity, either moisture content (mass by mass) u [kg/kg], moisture content (mass by volume) w [kg/m^3], or moisture content (volume by volume) Ψ [m^3/m^3] is used.

3.6
moisture damage
damage (3.3) in the building originating in (gaseous/liquid/solid) water

3.7
salt damage
damage (3.3) due to salt, including corrosion of metal materials caused by touching with salt in the air, cracks in the concrete from the corrosion/expansion of reinforcing steel rod due to salt adhesion, and detachment, etc., caused by crystallized/deposited salt in ceramic materials

Note 1 to entry: Visible salt deposition on surfaces can cause aesthetic problems.

4 Moisture transport mechanism

To make moisture planning meaningful, the critical moisture levels shall be well defined. However, these boundaries are always more or less uncertain. The solution may be to introduce some degree of safety margin. The size of the safety margin that should be introduced depends on the severity of the impact of a moisture state above the critical one. In cases where the degradation rate can be controlled, it is sometimes even possible to allow moisture levels above the critical, if this does not affect the indoor climate, health or the expected lifespan of the material or the structure.

Moisture in building porous materials transfers as vapour or liquid.

Vapour transfers as diffusion and effusion caused by vapour pressure gradients, and as the diffusion caused by temperature gradient.

Liquid transfers as capillary flow caused by the gravity in capillary suction. For vertical direction, liquid transfers also by gravitation.

In the presence of gradient in total air pressure, liquid and vapour transfer due to the gradient in total air pressure in addition to the mechanisms described above. This is classified as a transfer by convection. Wind pressure and difference in air pressure caused by difference between indoor and outdoor air temperatures are typical examples that cause convective transfer of vapour and liquid through cracks in or between building materials and also through permeable porous material. Mechanical ventilation will also influence the gradient in total air pressure.

5 Moisture sources

Moisture sources in building can be classified by the time of generation as follows:

a) generated before construction;

b) generated during construction;

c) generated after construction.

Table 1 presents examples of moisture sources. The letters in the bracket (a, b, or c) denote that the moisture source can generate at the time categorised above.

Table 1 — Moisture sources' examples

Moisture sources	(a) Generated before construction	(b) Generated during construction	(c) Generated after construction
Precipitation	(a)	(b)	(c)
Vapour outside the building	(a)	(b)	(c)
Vapour inside the building	(a)	(b)	(c)
Water in soil (liquid and vapour)	(a)	(b)	(c)
Built-in moisture (initially contained in the material)	(a)	(b)	(c)
Leakage		(b)	(c)
Water from adhesive		(b)	(c)
Post occupancy water use, e.g. shower, baths, dishwasher, wet cleaning of floor			(c)

6 Moisture damage

In order to refer to moisture damage, a phenomenon shall satisfy both of the following two conditions.

(1) A phenomenon which causes damage.

(2) A phenomenon is directly related to (gaseous/liquid/solid) water.

This is the definition of moisture damage, which is described in Figure 1.

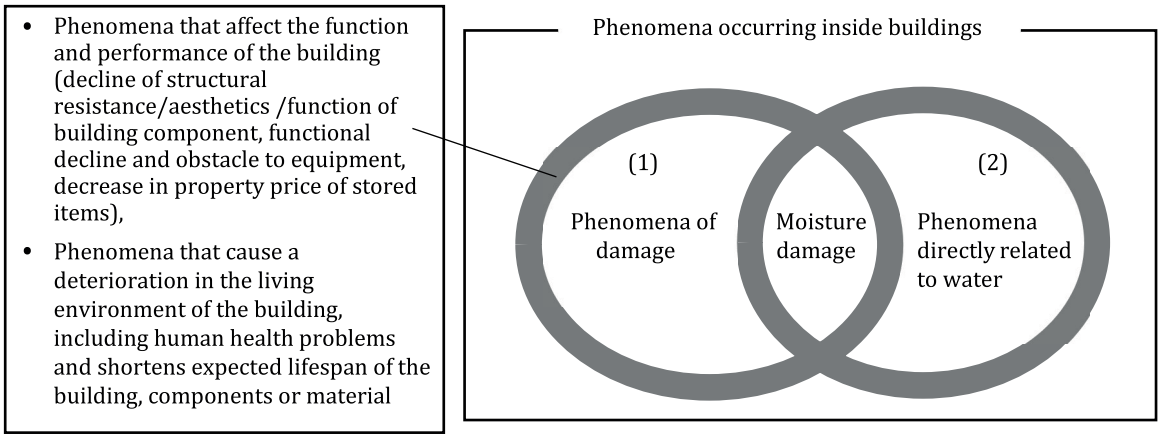

Figure 1 — Definition of moisture damage

7 Phenomena resulting from moisture

7.1 Algae/bryophyte

"Algae" is the generic term for a living being that performs photosynthesis on the earth other than bryophyte, fern plants, and seed plants, and includes blue algae (cyanobacteria) and green algae, etc. Bryophyte includes moss, liverwort and hornwort. When the materials are placed under the outside weather conditions, moisture content on the surface or the water droplets adhere to the surface may breed algae or bryophyte and may cause aesthetic problems. If the humid conditions are prolonged, it is more likely that algae and bryophyte are observed.

Related terms: condensation, high humidity.

7.2 Aesthetic changes

Wetting of a material that results in changes to pigments or accelerates other processes that result in staining or discolouration.

Related terms: wetting, condensation, colour fading, stain.

7.3 Condensation

Condensation is the change of the physical state of water from gas phase into liquid phase. Condensation occurs on a surface that is at or below the 'dew point' temperature.

Related terms: wetting, high humidity.

7.4 Corrosion

Corrosion means that a metal is altered or is consumed from the surface due to the rust by oxidization, or electrolytically by the differences of ionization tendencies. In some metals, when it rusts on the surface, it works as a protective film, and it does not spread any further.

Related term: rust.

7.5 Crack

Cracking that occurs when the amount of deformation of the object exceeds a critical limit. This is caused by the action of load, shrinkage or expansion due to temperature and humidity change. Particularly, it may reduce the proof stress or durability of materials such as concrete, mortar and plaster. This also

causes deterioration in appearance on the finished surface. In the field of painting and coating, small cracks and large cracks are called checking and cracking, respectively. Also known as “fissure”.

Related terms: expansion, shrinkage, peeling, exfoliation, delamination, adhesion loss.

7.6 Creaking

Increased noise or abnormal sounds generated by materials affected by change in moisture content. Doors, sliding doors, etc. do not open or roll smoothly, making gnawing or abnormal sounds. This is caused by deformation due to expansion or shrinkage of materials. In addition, the exterior material sometimes makes an abnormal sound due to expansion or shrinkage caused by temperature change.

Related terms: shrinkage, low humidity, expansion, high humidity, deformation, warpage.

7.7 Deformation

Change in the shape of an object due to stress from expansion or shrinkage.

Related terms: expansion, high humidity, shrinkage, low humidity, warpage, floating.

7.8 Dissolved destructive elements

Water transport of dissolved, destructive elements (e.g. salt, acid rain) which cause accelerated deterioration of building materials.

Related term: corrosion (electrolytic) of metal.

7.9 Dissolution

Refers to various materials where the performance is compromised due to water activity or moisture. In this document, it refers to materials that re-emulsify when in prolonged contact with water.

Related term: wetting.

7.10 Expansion

Increase dimension or volume of an object. This is due to physicochemical causes such as rise in temperature and humidity. In this document, this term mainly means that the volume of porous materials increases due to moisture absorption. Also, when moisture inside a material freezes, expansion occurs.

Related terms: high humidity, wetting, freezing, swelling, thrust up.

7.11 Floating

This means that a bonded surface, or a coated overlaid surface, disengages. For example, mortars applied to a concrete substrate or plastered foundation layers and tiles delaminate due to drying and shrinkage. This is also known as “skin separation”. It is also an indication of a state in which the inside of the material expands due to frost damage, peeling occurs and the surface rises.

Related terms: peeling, exfoliation, delamination, adhesion loss, freezing.

7.12 Floor squeak/floor squeaking

This is the squeaking sound that comes from the gap between the floor material and underlayment. Also refers to the rustling sound caused by the floor’s (mainly the flooring’s) joints. This is caused by shrinkage, expansion, floating or warpage of the material.

Related terms: expansion, warpage, shrinkage, floating.