INTERNATIONAL STANDARD

ISO 15928-3

First edition
2009-02-15

Houses — Description of performance —

Part 3: Structural durability

Constructions d'habitation — Description des performances —

Partie 3: Durabilité de la structure

Reference number
ISO 15928-3:2009(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15928-3 was prepared by Technical Committee ISO/TC 59, *Building construction*, Subcommittee SC 15, *Performance criteria for single family attached and detached dwellings*.

ISO 15928 consists of the following parts, under the general title *Houses — Description of performance*:

— *Part 1: Structural safety*

— *Part 2: Structural serviceability*

— *Part 3: Structural durability*

— *Part 4: Fire safety*

Introduction

This part of ISO 15928 is one of a series under the general title: *Houses — Description of performance*. The objective of this series is to identify the methods used to describe the performance of houses. Each part of ISO 15928 relates to a separate attribute. The parts of ISO 15928 do not specify levels of performance and they are not intended to replace national standards or regulations, but to provide a standardized framework to enable the development of national standards and regulations in accordance with World Trade Organization (WTO) requirements. The parts of ISO 15928 do not provide design methods and/or design criteria.

Based on the framework provided by ISO 15928 (all parts), purchasers, regulators and standard writers in their respective countries can describe their requirements in standardized performance terms. Additionally, the manufacturers/providers can respond by describing the performance of their products in a similar manner. The purpose of ISO 15928 (all parts) is to provide a standardized system that can be used to specify performance requirements and performance levels or to rate housing products.

NOTE The WTO *Agreement on technical barriers to trade*, Clause 2.8, states: "Whenever appropriate, members shall specify technical regulations based on product requirements in terms of performance rather than design or descriptive characteristics".

Houses — Description of performance —

Part 3: Structural durability

1 Scope

This part of ISO 15928 sets out a method for describing the structural durability performance of houses. It covers the needs of the user, provides performance descriptions, establishes parameter descriptions and outlines evaluation processes.

This part of ISO 15928 is intended for use in the evaluation of the design and construction of houses, in the international trading of houses or their subsystems and in developing quality systems for houses.

This part of ISO 15928 does not apply to structural safety, serviceability or other attributes, which are covered in other parts of ISO 15928.

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.

ISO 2394, *General principles on reliability for structures*

ISO 15928-1, *Houses — Description of performance — Part 1: Structural safety*

ISO 15928-2, *Houses — Description of performance — Part 2: Structural serviceability*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2394 and the following apply.

3.1
house
building occupied for residential purposes, which may be separated or linked horizontally, but not linked vertically to another, which has its own access and which does not share any common space with another

3.2
parameters
⟨structural durability⟩ group of variables used to quantitatively describe the structural durability performance

3.3
performance
behaviour of houses related to users' needs

3.4
components
〈including fixtures〉 parts of a house that can be identified such as floor, wall, etc.

3.5
structural durability
capability of a structure or any component to satisfy, with planned maintenance, the structural design performance requirements over a specified period of time under the influence of the environmental actions, or a result of a self-ageing process

3.6
design life
period of time for which the structural unit or component performs above the specified level of structural safety and serviceability performance

3.7
design working life
design life assumed for the whole house

3.8
maintenance schedule
series of actions and time intervals between these actions to maintain the levels of structural safety and serviceability performance of the whole house over the design working life

4 Structural durability performance

4.1 User needs

The structural safety and serviceability performance of the house shall be acceptable to the user over the specified design working life.

A specified maintenance schedule can be required to achieve this. It is assumed that no significant human abuse occurs.

4.2 Performance descriptions

The performance description for structural durability is the expression of the ability of the whole house and its parts, with an appropriate degree of reliability, to fulfil its intended safety and serviceability performance in the environment in which it is located over the specified design working life when subject to its intended use. This is expressed in terms of one or more of the following:

a) external and internal environmental agents (including those associated with microclimates that can arise in buildings);

b) maintenance schedule and specified component design life;

c) changes in form or properties.

NOTE 1 Performance in the environment refers to performance when subjected to the environmental agents listed in Table A.1. This includes harmful substances and phenomena (e.g. aggressive ground water, acid rain, polluted air, insect or rodent attack and fungal decay). It is necessary to consider the effects of severe events when defining the environmental agents.

NOTE 2 Changes in form or properties of components and materials induced by the environment can be described in terms of:

a) change in basic properties of materials;

b) change in general or local dimensions of components;

c) change in properties or form of connection between components.

4.3 Principles for describing structural durability performance

The structural durability performance can be described in terms of

a) the component design life,

b) the maintenance schedule, and

c) the internal and external environmental agents that are likely to occur in the design working life.

The required maintenance should not be excessive, nor should the replacement of components be at inappropriate levels. Maintenance requirements should be specified only for readily accessible components.

5 Parameters for the description of performance

5.1 Parameters for describing component design life

The component design life shall be described by specifying the minimum time, expressed in years, between the replacement of structural components under the specified maintenance schedule.

5.2 Parameters for describing the maintenance schedule

The maintenance schedule shall be described by specifying the level of maintenance and frequency of maintenance for the structural components and units.

NOTE Guidance on parameters required can be found in ISO 15686-5.

5.3 Parameters for describing internal and external environmental agents

5.3.1 General

The parameters for describing internal and external environmental agents considered relevant to the structural durability are:

a) the geographical location of the house;

b) the parameters describing the influences of environmental agents affecting structural durability.

5.3.2 Parameters for geographical location

The parameters for describing geographical location include:

a) the distance from a coast-line, other geographical features or sources of pollutants;

b) the climate zone;

c) the physical location, e.g. latitude and longitude.

5.3.3 Parameters describing environmental agents

5.3.3.1 The following influences should be considered:

a) moisture constituents;

b) moisture contaminants;

c) air constituents;

d) air contaminants;

e) ground constituents;

f) ground contaminants;

g) biological agents/life;

h) temperature;

i) solar radiation;

j) incompatible chemicals;

k) use or exposure.

5.3.3.2 Where appropriate, the following parameters should be used to quantify these influences:

— duration of wetness;

— duration of exposure;

— freeze-thaw cycles;

— temperature;

— pH value for acidity;

— concentration of chemicals and contaminants.

An assessment should be made as to whether these influences act either individually or in combination.

6 Evaluation

6.1 General

ISO 13823 describes the following two procedures for the evaluation of structural durability performance.

a) Service life format: This procedure consists of ensuring that the predicted structural design life of a whole house or component, allowing for variations in durability, equals or exceeds the specified design life of the house or component.

b) Limit state format: This procedure consists of ensuring that, at all the times during the specified design life of the whole house or component, the performance requirements for structural safety and serviceability are satisfied.

6.2 Evaluation methods

6.2.1 General

Performance or properties for both whole house and components and material over time for a specified environment and maintenance schedule can be determined by

a) field testing,

b) laboratory testing,

c) service experience,

d) analysis, or

e) a combination of the above.

6.2.2 Field testing

Full-scale dwellings, assemblies, components or materials in dwellings can be exposed to a real environment for a stipulated length of time prior to the determination of structural safety or serviceability performance. It is necessary that scientifically justified principles be used to relate the performance after the exposed time to that at the design working life or component life, as appropriate.

NOTE Guidance on the relevant principles can be found in ISO 15686-2.

6.2.3 Laboratory testing

Accelerated ageing in laboratory facilities may be used for all testing (whether for whole dwellings, components, assemblies or materials) prior to the determination of structural safety or serviceability performance in accordance with the methods in ISO 15686-1 and ISO 15686-2. It is necessary that scientifically justified principles be used to relate the performance in the laboratory test to that in reality.

6.2.4 Service experience

Service experience may be used in the assessment of the working life either of the whole house or of the component life (see ISO 15686-2). It is necessary to derive the data from a sufficient number of representative examples exposed to similar or more severe conditions. It is also necessary that construction methods, components and materials be similar to those of the houses being analysed. It is necessary to have available adequate documentation of environments and the performance over time.

NOTE Guidance on appropriate methods to extract service life data from the appraisal of existing buildings can be found in ISO 15686-7.

6.2.5 Analysis

Analytical methods may be used to assess the durability performance of individual components. Individual component analysis is required to assess

a) the change in form or properties over the component design lifetime, taking into account the maintenance schedule and the environmental agents;

b) the effect of these changes on structural safety and serviceability performance.

6.2.6 Combination

A combination of field and laboratory testing, service experience and analysis may be used for evaluation.

Annex A
(informative)

Commentary

A.1 General

This annex includes background information on this part of ISO 15928, guidance on its use and suggestions on good practice.

A.2 Comments on the Scope (Clause 1)

The purpose of this part of ISO 15928 is to standardize the method of describing the structural durability performance for housing, i.e. to standardize the parameters by which the structural durability aspects of house performance are expressed or defined. This part of ISO 15928 does not specify a level of performance and it is not intended to provide design method and/or criteria.

It is one in a series of parts that together comprise ISO 15928, which is designed to facilitate the communication between the specifier (buyer/user) and the provider (seller). Durability and safety attributes are covered in other parts of ISO 15928.

The intent is to provide a standardized system that can be used to realize performance description.

The objectives of this part of ISO 15928 are as follows:

a) to facilitate international trade in housing systems and housing products, and to exchange housing information and knowledge by eliminating technical barriers;

b) to facilitate innovation in housing by providing a systematic framework for evaluation and acceptance;

c) to establish user needs related to structural serviceability in specific technical engineering terms, in order to facilitate communication among all stakeholders.

This part of ISO 15928 can also be useful in increasing consumer product awareness and in developing quality systems for houses.

The application of this part of ISO 15928 is only to the durability of structural components in houses. It does not apply to non-structural components, such as internal fixtures. It is intended for use in conjunction with ISO 15928-1 and ISO 15928-2.

A.3 Comments on the normative references (Clause 2)

Only references required for the application of this part of ISO 15928 are listed in this clause. Other useful information can be found in the Bibliography.

A.4 Comments on the terms and definitions (Clause 3)

In general, the adopted definitions are those given in ISO 6240, ISO 6241 with regard to performance and ISO 2394 with regard to structural terms except for the following terms that require further elaboration.

a) The design working life of the whole house: the period of time when structural safety and serviceability meet the required level as specified in ISO 15928-1 and ISO 15928-2, respectively. It is necessary that throughout this working life the probability of structural failure of the house be less than an accepted limit.

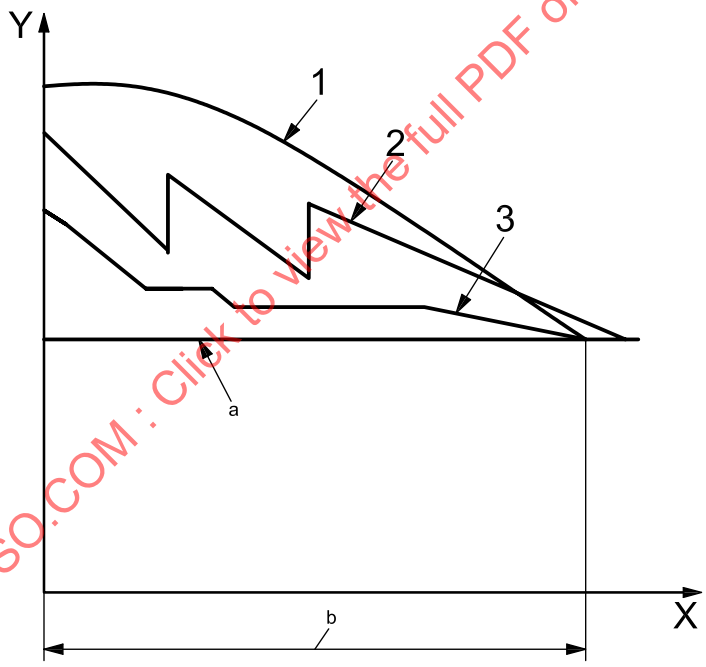
b) The specified component life: the period of time that a particular component meets a similar performance requirement.

c) The specified component design life: this need not necessarily match the design working life of the whole house if the component can be readily replaced. In this case, as long as replacement is specified the component design life can be a fraction of the working life of the whole house. However, where the component cannot be readily replaced then it is necessary for the specified component design life to match or exceed the design working life of the whole house.

A.5 Commentary on the structural durability performance (Clause 4)

A.5.1 Comments on user needs (4.1)

Figure A.1 indicates how three different maintenance strategies can provide acceptable performance over the design working life of a house.



Key

1 strategy 1 (no maintenance)
2 strategy 2 (with repair)
3 strategy 3 (with maintenance)

[a] Target performance.
[b] Design life.
X time
Y performance level

Figure A.1 — Strategies for acceptable performance over design working life of a house

The maintenance can necessitate repair or replacement of specific components. Accordingly, the component life of readily replaceable components need not match the specified design life.

A.5.2 Comments on performance descriptions (4.2)

The specified design working life referred to in this clause is for the whole house (see ISO 2394). It is possible to establish the specified design life of components in terms of how readily components are replaceable and the consequence of their failure on the overall maintenance of structural safety and serviceability performance. (Thus roof coverings, which are easily replaced, may have a shorter design life than framing members, for example.)

A.5.3 Comments on principles for describing structural durability performance (4.3)

In many instances, it is difficult to quantify directly the effect that environmental agents over time can have on the level of structural safety or serviceability of a whole house. However, it is possible to estimate or quantify the effect that environmental agents will have on the structural form or properties of individual components. Analytical procedures can be used to assess the effects that these changes in form or properties can have on structural safety or serviceability.

For example a steel beam within a dwelling exposed to marine air will corrode over time. It is possible to estimate the maximum loss of cross-sectional area of the beam after given times of exposure. Analytical methods can then be used to assess whether this loss in cross-sectional area will reduce the structural safety of the dwelling. Alternatively, the minimum possible cross-sectional area of the beam required to give acceptable structural safety can be determined. Then, as long as the cross-sectional area of the exposed beam remains above this minimum, the corrosion of the beam will not impair the structural safety of the dwelling.

A.6 Comments on parameters for the description of performance (Clause 5)

A.6.1 Comments on parameters for describing component design life (5.1)

The minimum component design life should be specified taking into account any forecast changes in the environment, and the interdependence between components and connections. The level of accessibility of the component should also be taken into account when specifying the component life. For example the design life of metallic roof sheeting could be less than the design working life of the whole house. However, the design life of the metal roof sheeting should not be less than the specified design life of its fastener.

A.6.2 Comments on parameters for describing the maintenance schedule (5.2)

Definitions of types of maintenance and maintenance activity can be found in ISO 15686-5. Types of maintenance include preventive, scheduled, corrective, conditioned–based, emergency/unforeseen, predictive and deferred. Activities include inspection, monitoring, testing, condition surveys/inspections, maintenance planning or repairing/refurbishing. In principle within these definitions three broad strategies could be adopted.

a) Inspect and maintain according to a pre-determined schedule based on prior understanding of rate of degradation;

b) Instigate procedures to permit regular update on building condition (condition surveys/inspections) and repair when a given level of damage occurs;

c) Repair only after the component has failed.

Where the failure of particular components can pose a risk to structural safety, the third approach is unacceptable. It is acceptable, for example for the failure of window glass. If the first approach is to be adopted then a conservative estimate of the period of time required for the component to show an unacceptable level of change in form or properties is necessary and the inspection interval should be an agreed fraction of this time.

Strategies other than maintenance can be deployed to allow the life of each component to satisfy the design working life of the whole house. It is possible to replace components (given that their degradation poses no

risk to structural safety up to the point of replacement) or the dwelling can be designed so that degradation is limited and the component lifetime exceeds that of the design working life of the whole house (see ISO 13823).

A.6.3 Comments on parameters for describing internal and external environmental agents (5.3)

Table A.1 is derived from ISO 13823:2008, Annex B. This table describes the various influences on structural durability along with the agents giving rise to them and examples of parameters that can be used to describe the relevant structural durability performances.

Table A.1 — Examples of agents causing environmental action

Influence	Agent	Example of parameters [a]
Moisture constituents	Solid (ice, snow) Liquid (rain, condensation) Gas (water vapour)	TOW, RH
Moisture contaminants	Chlorides, acids or sulphates	TOE, RH, pH, concentration
Air constituents	O_2, CO_2	TOE, concentration
Air contaminants	Oxides, particulates and sea spray	TOE, concentration
Ground constituents	Sulphates and other salts Acids (from decomposition of organics)	TOE, RH, pH, concentration
Ground contaminants	Chemicals from spills and leaks Chlorides from road salt Induced electric currents	TOE, RH, pH, T, concentration
Biological agents/life	Microorganisms, insects, animals and plants	TOW, RH, T, geographical
Temperature	Freeze-thaw cycles	F-T(T, t)
Solar radiation	UV radiation, IR radiation	TOE, T, RH
Incompatible chemicals		TOE, concentration
Use or exposure	Wear, abrasion	TOE, load

[a]
TOW time of wetness — pH acidity
TOE time of exposure — t time
F-T freeze-thaw cycles — concentration concentration of constituents and contaminants
T temperature — load mechanical load

The ISO International Standards listed in Table A.2 can contain information relevant to the description of parameters for internal and external agents.

Table A.2 — ISO International Standards pertinent to description of parameters

Parameter for internal and external agents	International Standard
Solar radiation	ISO 4892-1, ISO 4892-2, ISO 4892-3, ISO 9370
Freeze-thaw cycles	ISO 1147
Humidity	ISO 4677-1, ISO 4677-2
Ozone levels	ISO 10313, ISO 13964
Airborne contaminants	ISO 4221, ISO 7996, ISO 9225, ISO 10062, ISO 11564
Airborne salinity	ISO 9225
Ground constituents	ISO 10390, ISO 10573
Fungi and moulds	ISO 846

The parameters specified should only be those which relate to degradation leading to loss of structural safety and serviceability. Influences that can affect other requirements only, such as aesthetics or general functionality, are not included.

Localized conditions can arise in particular spaces or parts of spaces in the interior, within the fabric or on the façade of a house. It is possible for these localized microclimates to differ considerably from the general indoor or exterior climate. Where such microclimates are likely to occur, it is necessary for them to be identified and the level of influences determined separately for such microclimates.

A.7 Commentary on evaluation (Clause 6)

A.7.1 General (6.1)

The two alternative methods are described in more detail in ISO 13823:2008, 7.2.

For the approach using the service life format a methodology is presented in ISO 13823:2008, Clauses 8 and 9, for determining the predicted service life. For the approach using the limit state format, which is a more complex approach, an example of its application is presented in ISO 13823:2008, Annex A.

A.7.2 Comments on evaluation methods (6.2)

A.7.2.1 General

No commentary.

A.7.2.2 Comments on field testing (6.2.2)

Field testing potentially provides the most accurate testing method as the test is being carried out in the actual service condition in which the final house will be built. The major issue for field testing of full-scale dwellings is the appropriate selection and sampling of exposure environments. Performance in actual situations can only be conservatively estimated if the environment used in field testing is as, or more, severe than that of the actual situations. A strategy of characterizing the range of actual environments into severity bands and ensuring that field tests are carried out in each band can be an appropriate method to guarantee the reliability of field testing. Guidance on characterizing environmental impacts can be found in ISO 15686-6.

Field testing of components can be carried out in a number of ways including:

a) exposure of the components within a dwelling;

b) open exposure of a component.

If the component is to be exposed in a dwelling it is important to guarantee that the severity of the dwelling exposure is appropriate (as discussed above) and that the component is exposed in the most aggressive situation likely to be encountered in actual service. Open exposure of components to the external environment is the more frequent exposure method and will frequently lead to accelerated degradation as the environmental conditions will frequently be more severe than in the actual dwelling. The key challenge is to determine whether the exposure conditions are relevant to the probable service conditions and to what extent the degradation will be accelerated. Guidance on these issues can be found in ISO 15686-2.

ISO 15686-2:2001, Annex A, expands on service life prediction methodologies and highlights factors that need to be considered to allow the performance of components at the design working life of the dwelling to be evaluated from testing on shorter duration. It is important that:

a) degradation agents and/or combination of agents in service be identified;

b) possible degradation mechanisms in service be identified;

c) valid and reproducible performance evaluation techniques in both in-service and short-term studies be undertaken;

d) major degrading agents and degradation methods in the testing regime match those of the service conditions.

A.7.2.3 **Comments on laboratory testing** (6.2.3)

Laboratory testing should follow the basic principles outlined in ISO 15686-2. The following three general methods are outlined for accelerated short-term exposure.

— Reference components/comparative exposures: these are used to rank the performance of new components against old components where the lifetime of the old component is well documented and can be used to estimate a service life.

— Simulated and accelerated environmental exposures: these techniques simulate the exposure to the critical environment agent and require the level of acceleration in ageing to be estimated (usually from the relative intensity of degrading agents and a degradation model).

— Acceptance exposures: normally such accelerated exposures are designed with pass or fail exposure requirements that are derived from the experience of similar components in the service.

A.7.2.4 **Comments on service experience** (6.2.4)

ISO 15686-7 sets out procedures for estimating the service life of components from “practice”. Here practice refers to information gained from a periodic programme of building inspections. ISO 15686-7:2006, Annex A, also sets out an Environmental classification scheme which can be used to assess whether the house or houses surveyed (or components in the house) are exposed in similar or more severe conditions than the house being analysed. ISO 15686-7:2006, Annex B, sets out methods to be applied to use the data derived from a population of buildings to provide estimates of service life of buildings or components. This annex includes a discussion of the use of a probabilistic approach and the definition of a distribution of performance.