
**Houses — Description of
performance —**

**Part 1:
Structural safety**

*Constructions d'habitation — Description des performances —
Partie 1: Sécurité de la structure*



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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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 59, *Buildings and civil engineering works*, Subcommittee SC 15, *Performance description of houses*.

This second edition cancels and replaces the first edition (ISO 15928-1:2003), which has been technically revised.

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*
- *Part 5: Operating energy*

The following part is under preparation:

- *Part 6: Sustainable development contributions*

Introduction

This part of ISO 15928 is one of a series of standards. The objective of the ISO 15928- series is to identify the methods that will be used to describe the performance of houses. The ISO 15928- series is confined to buildings occupied for residential purposes that may be separated or linked horizontally, but not linked vertically, and which have their own access and do not share any common space.

Each part of the ISO 15928- series 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 provide a standardized framework to be used for development of national standards and regulations consistent 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 the ISO 15928- series, purchasers, regulators and standards-preparers in respective countries can describe their requirements in standardized performance terms, as appropriate. Additionally, the manufacturers/providers can respond by describing the performance of their products in a similar manner.

The purpose of this part of ISO 15928 is to provide a standardized system of describing performance that can be used to specify performance requirements and performance levels, or to rate houses, in terms of structural safety.

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."

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Houses — Description of performance —

Part 1: Structural safety

1 Scope

This part of ISO 15928 sets out a method for describing the structural safety performance of houses. It covers objectives, provides performance descriptions, establishes parameter descriptions, and outlines evaluation processes. It includes a description of permanent, imposed, wind, seismic, snow and other actions as well as structural resistance.

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 sub-systems, and in developing risk-management tools for the protection of houses.

The ISO 15928- series does not specify a level of performance and it is not intended to provide a design method and/or criteria.

It describes the structural safety of a house as a whole.

NOTE 1 [Annex A](#) includes background information on this part of ISO 15928, guidance on its use, and suggestions on good practice.

NOTE 2 Details on references referred to in Notes are provided in a Bibliography.

NOTE 3 Structural serviceability, durability and other attributes are covered in other parts of ISO 15928.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 6707-1, *Buildings and civil engineering works — Vocabulary — Part 1: General terms*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2394, ISO 6707-1 and the following apply.

3.1 action

force acting on a structure, or cause of deformation imposed on a structure or constrained within it

Note 1 to entry: In North America, the term 'load' is preferred and used in place of 'action'.

Note 2 to entry: In ISO 15928, the term 'load' is used to indicate the value of a force corresponding to an action.

Note 3 to entry: See ISO 6707-1:2014, 9.3.22 for the definition of 'force'.

3.2

basic ground snow depth

ground snow depth for a particular site before modifications are made for surrounding environment

3.3

basic wind speed

wind speed at a specified height and a specified terrain for a particular site before modifications are made for surrounding environment

3.4

house

building occupied for residential purposes and designed as one unit (dwelling) with its own access

Note 1 to entry: The house can be a separate building, or linked horizontally with another house but not linked vertically.

Note 2 to entry: Where houses are linked, each has its own access and does not share any space in common with another.

Note 3 to entry: Where houses are linked, services including those related to energy usage and supply, heating and ventilation may be shared.

Note 4 to entry: Where houses are linked, the wall between the houses is typically designed and constructed to limit the probability of fire spread between houses.

Note 5 to entry: See ISO 6707-1:2014, 3.1.3 for the definition of 'building'.

3.5

objective

statement concerning the purpose of the description of performance which is to express user needs

3.6

parameters

<structural safety> group of variables used to quantitatively describe the structural safety performance

3.7

performance

behaviour of houses related to use

3.8

representative value of an action

value used as a reference for the description of performance

4 Structural safety performance

4.1 Objective

The structural capacity of a house to resist all actions which may affect the safety of the occupants of the house and may also lead to property damage to the house or an adjacent property, shall be such that the risk of collapse or other kind of severe damage resulting from structural failure shall not exceed a level acceptable to the user.

4.2 Performance description

The performance description is the capacity of the whole house and its parts, with an appropriate degree of reliability, to maintain their strength and stability under all actions likely to occur.

The structural safety performance may be described by the magnitudes of the structural actions on the house and the resistance behaviour of the house under the effects of those actions.

NOTE 1 The appropriate degree of reliability can be judged with due regard to the possible consequences of failure and the expense level of effort and procedures necessary to reduce the risk of failure. Aspects that are important in achieving the proper degree of reliability include choice of structural systems, design and analysis, durability design, quality control, maintenance and protective measures.

NOTE 2 For the purposes of this part of ISO 15928, the durability of materials are not considered to have a bearing on the structural performance of the house.

5 Parameters for the description of performance

5.1 Parameters for describing actions

5.1.1 Permanent actions

The permanent actions, other than self-weight, are described by the magnitude(s) in kilonewtons and the location(s) of the imposed load(s).

5.1.2 Imposed actions

The imposed actions are described by the representative values of one or more of:

- a) a uniformly distributed floor or roof load, in kilopascals,
- b) a concentrated floor or roof load, in kilonewtons, over a specified area, in square metres,
- c) a concentrated wall impact load, in kilonewtons, applied at a specified height, in metres, above the floor, and
- d) a uniformly distributed horizontal line load, in kilonewtons per metre, applied at a specified height, in metres, above the floor.

NOTE 1 ISO 2103[1] provides minimum recommended imposed actions for different types of use and occupancy.

NOTE 2 An example of d) is the load on a hand rail.

5.1.3 Wind actions

Wind actions are described by the representative value of the wind velocity, in metres per second, derived from the basic wind speed, factored as appropriate to take into account local effects, terrain, shielding, topography, altitude, etc., based on one of the following wind velocity types:

- a) 3-s gust;
- b) 1-min mean;
- c) 10-min mean;
- d) hourly mean.

The effect of windborne debris on internal pressures should be considered.

NOTE Refer to ISO 4354[2] for details on the conversion of wind velocity to wind forces and conversion between different types of wind velocity.

5.1.4 Seismic actions

Seismic actions are described by stating the representative value of one of the following parameters:

- a) the effective peak ground acceleration, expressed as a fraction of gravity;
- b) the base shear coefficient;
- c) the ground acceleration response spectrum for the site.

The proportion of the imposed loads to be included in the seismic mass shall also be nominated.

The representative value shall be based on a consideration of the seismic activity, the soil characteristics of the construction site and the response behaviour of the structure.

NOTE ISO 3010[3] provides additional information on seismic action on structures.

5.1.5 Snow actions

The snow actions are described by stating the representative values of:

- a) the ground snow depth, in metres, derived from the basic snow depth, factored to take into account local effects such as terrain, shielding, topography, etc.;
- b) the snow density, in kilograms per cubic metre, i.e. the density to be used in converting the ground snow depth into a load; and
- c) the duration, in days per year.

NOTE ISO 4355[4] provides information on the conversion of ground snow depths to roof snow loads.

5.1.6 Other actions

Consideration shall be given to the description of other actions arising from floods, tornados, tsunamis, potentially unstable sites, windborne debris, temperature, impact, explosion etc., if these actions are likely to affect the safety of the house.

5.1.7 Combinations of actions

Consideration shall be given to the description of the combinations of the actions to account for the probability of simultaneous occurrence of two or more actions.

5.2 Parameters for describing structural resistance

5.2.1 General

The resistance of the house under the effects of the actions can be described in terms of limit state criteria or allowable stress criteria for materials with recognized engineering properties in accordance with 5.2.2 or 5.2.3 and ISO 2394 where appropriate. Materials without recognized engineering properties may be described in accordance with ISO 2394.

Reference should be made to relevant International Standards when available.

5.2.2 Resistance based on limit state criteria

The following information shall be provided:

- a) strength reduction factor (resistance factor or partial safety factors);
- b) characteristic material strengths;

- c) testing methods from which the characteristic material strengths are determined.

5.2.3 Resistance based on allowable stress criteria

The following information shall be provided:

- a) factor of safety for stress criteria;
- b) characteristic material strengths;
- c) testing methods from which the characteristic strengths are determined.

6 Evaluation

6.1 General

Evaluation may be carried out by:

- a) analysis,
- b) testing,
- c) service experience, or
- d) combination of the above.

The characteristic values of material properties used for analysis should be derived from International or other appropriate test standards.

6.2 Analysis

Action effects on individual structural members shall be determined by methods of structural analysis that take into account equilibrium, general stability, geometric compatibility, and both short- and long-term material properties. Members that tend to accumulate residual deformations under repeated service loads shall have included in their analysis the added eccentricities expected to occur during the design working life.

6.3 Testing

Testing shall incorporate a realistic representation of materials, loading conditions, boundary conditions and construction practices. Testing for evaluating structural response shall be full scale unless all scale effects can be appropriately estimated.

NOTE See ISO 2394:2015, Annex D, for the use of testing in design.

6.4 Service experience

Service experience shall comprise a sufficient number of representative examples, exposed to similar or more severe service conditions, together with adequate documentation.

6.5 Combination

A combination of analysis, testing and service experience may be used for evaluation. Simplified analytical procedures using a combination of testing and service experience may be used.

Annex A (informative)

Commentary

A.1 Scope

The purpose of this part of ISO 15928 is to standardize the method of describing the structural safety performance for housing, i.e. to standardize the parameters by which the structural safety 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 part of a series of ISO standards designed to facilitate the communication between the specifier (buyer/user) and the provider (seller). Structural serviceability, durability and fire safety attributes are covered in other parts of ISO 15928.

The intent is to provide a standardized system that is to 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 safety in specific technical engineering terms in order to facilitate communication among all stakeholders.

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

A.2 Normative references

General building and civil engineering terms are defined in ISO 6707-1:2014. Information relevant to structural safety performance is from ISO 2394:2015. Other useful information can be obtained from the Bibliography.

A.3 Terms and definitions

In general, the adopted definitions are those given in ISO 6707-1 with regard to building terms, and ISO 2394 with regard to structural terms, except for the following terms, used in [A.4](#), that require further elaboration:

- a) *Action and load*: the term “action” is used to indicate the agent that affects the structural performance and the term “load” is used when the action is quantified.
- b) *Design value of an action*: value obtained by multiplying the representative value by the appropriate load factor.
- c) *Representative value of an action*: ISO 2394 defines representative values as “the values used for verification of a limit state which consist of characteristic values, combination values but may also consist of other values”. In this part of ISO 15928, the word is used to designate the value used as reference for the description of performance.

- d) *Load combination*: set of design values used for the verification of a design under the simultaneous influence of different actions.
- e) *Load factor*: the factor by which the representative value of an action is multiplied to give the design value for a particular load combination.

A.4 Structural safety performance

A.4.1 Objectives

The objectives or users' needs for structural safety are thought of in terms of the safety of people. Those inside the house may be injured by structural collapse and those in the vicinity of the house may be injured by flying debris as the result of structural failure. Properties are also protected to a certain extent by reducing the risk of structural failure. The acceptable level of performance may vary from user to user and will depend on user expectations.

A.4.2 Performance description

Safety is considered in relation to the strength and stability of the structure. The structural serviceability and durability characteristics, including maintenance, are considered in separate standards.

The performance objectives are the same as those stated in ISO 2394. The objective corresponds to the maximum load-carrying capacity and the overall stability of the house.

Structural safety performance can be described by the structural reliability (or probability of failure) in accordance with ISO 2394 or by describing the capacity of the house to sustain certain levels of actions without failure. The latter method is considered more practical in terms of trade and is used in this part of ISO 15928. Two methods to assess structural strength performance are currently in use, namely the 'ultimate limit state' and 'allowable stress design'. It is therefore necessary to refer to assessment method when describing strength performance.

A representative value for each of the actions that affect safety performance is first selected. The representative value is normally a characteristic value. This value together with the load factor will describe the safety performance. For example, a 500 or 1 000 year return value may be selected as the representative value for wind action together with a load factor of 1,0. Alternatively, a 50 year return value may be chosen as the representative value and a load factor of, say, 1,3 or 1,5 for the ultimate limit state if Limit State Design is used, or a load factor of 1,0 if Allowable Stress Design is used.

Table A.1 illustrates the relationship between the agents, the representative values of the parameters, the representative values of the actions and the design values of the actions.

Table A.1 — Examples of agents, parameters, representative and design values

Agent	Performance parameter	Representative value of the action	Design value for safety (Ultimate Limit States)	Design value for safety (Allowable Stress Design)
Imposed actions	Q (kPa or kN)	Q	$\gamma_Q Q$	Q
Wind actions ^a	V (m/s)	W_{50}, W_{500}	$\gamma_W W_{50}$ or $\gamma_W W_{500}$	W_{50}
Seismic actions ^b	A (m/s ²)	E_{500}, E_{100}	$\gamma_E E_{100}$ or $\gamma_E E_{500}$	E_{100}
Snow actions ^c	D_G, ρ (kg/m ³)	S_{20}	$\gamma_S S_{20}$	S_{20}
^a W_{50}, W_{500} are the 50 and 500 year return values for the wind load, respectively. ^b E_{500}, E_{100} are the 100 and 500 year return values for the seismic load, respectively. ^c S_{20} is the 20 year return value for the snow load.				

A.5 Parameters for the description of performance

A.5.1 Parameters for describing action

NOTE This Clause describes the parameters defining the actions that the specifier needs to supply to the provider. It is not concerned with the design issues that are wholly controlled by the designers. Other actions that need to be considered in design such as self-weight, etc. are therefore not mentioned here. Some national specifications may use different parameters for the description of the actions; these could still be used provided that they can be converted into the parameters adopted [A.5.1.1](#) Permanent actions.

A.5.1.1 Permanent actions

This clause is intended for specific permanent loads that need to be specified (e.g. water tank, chandelier). Their exact locations should also be specified.

A.5.1.2 Imposed actions

ISO 2103 provides representative values for minimum recommended imposed loads for different types of use and occupancy. There is no International Standard for specifying impact load at present but there are International Standards for impact testing, e.g. ISO 7892. [\[5\]](#)

A.5.1.3 Wind actions

Wind speed has been chosen as the parameter to represent wind action. The alternative is free-stream dynamic wind pressure; however, it is possible to convert one to the other. The representative value of the wind speed is the value of wind speed with appropriate modifications to account for the local conditions such as terrain or shielding. This approach is necessary because different methods have been used in national codes to allow for local conditions. The representative value can be expressed in one of a number of types of wind speed. ISO 4354 provides the conversion factor between different types of wind speed as well as the process to convert wind speeds into wind forces.

A.5.1.4 Seismic actions

There are various ways of describing seismic action. Peak ground acceleration and base shear coefficient are the most common ways. The representative values of these parameters should be chosen with appropriate consideration to account for the particular load conditions, such as seismicity of the region, soil characteristics of the site and the importance of the building. The dynamic property of the structure, however, is the responsibility of the provider. This approach is necessary because different methods have been used in national codes to allow for these conditions. The approach is consistent with the guidelines given in ISO 3010.

A.5.1.5 Snow actions

Ground snow depth and snow density have been chosen as the parameters to represent snow actions. The representative value for ground snow depth is the value of ground snow depth with appropriate modifications to account for the local conditions, such as shielding, zoning. This approach is necessary because different methods have been used in national codes to allow for these conditions. The representative value for snow density is the average snow density value used to convert snow depth into snow load. This approach is consistent with ISO 4355.

A.5.1.6 Other actions

These include the following:

a) Unstable sites

This parameter mainly affects the design of the foundation, but may have consequences on the overall performance of the house. Failure may also be caused by landslides, but this is not normally considered as being within the scope of structural safety and is treated as a planning issue.

b) Flooding

The flood height above ground and the flood flow speed can be used as the parameters to represent flood actions. The control of house building in flood-prone regions is generally treated as a planning issue. However, if house building is permitted in flood prone regions, then the above parameters will permit the provider to evaluate the structural consequence of flooding. Other parameters, such as frequency of flooding, may be relevant to other attributes such as durability, but not to structural safety.

A.5.1.7 Combinations of actions

The combinations of actions is dependent on the chosen design criteria, as follows:

a) Limit state criteria

For example, the following action combinations, incorporating nominated load factors γ_1 to γ_{15} , as appropriate, are normally considered:

- $\gamma_1 G$
- $\gamma_2 G + \gamma_3 Q + (\gamma_4 S)$
- $\gamma_5 G + (\gamma_6 W \text{ or } \gamma_7 E)$
- $\gamma_8 G + \gamma_9 Q + (\gamma_{10} S) + (\gamma_{11} W \text{ or } \gamma_{12} E)$
- $\gamma_{13} G - (\gamma_{14} W \text{ or } \gamma_{15} E)$.

b) Allowable stress criteria

For example, the following load combinations are normally considered:

- G
- $G + Q + (S)$
- $G + (W \text{ or } E)$
- $G + Q + (S) + (W \text{ or } E)$

where

- E is the seismic load;
- G is the permanent (dead) load;
- Q is the imposed (live) load;
- S is the snow load;
- W is the wind load;
- γ_1 to γ_{15} are the load factors for safety.

A.5.2 Parameters for describing structural resistance

A.5.2.1 General

The description of structural resistance includes the description of the method of analysis to determine the action effects from the actions. The structural model should reflect the behaviour of the structure, for the limit state or allowable stress criteria, being considered.

A.5.2.2 Resistance based on limit state criteria

The ultimate limit states relating to structural safety are described in ISO 2394 in terms of criteria for strength and/or deformation as well as stability. The limit state of strength and deformation, respectively, is defined in terms of maximum load-carrying capacity of the components and a certain limiting deformation. Usually, the limit state criteria consist of strength reduction factors and characteristic strengths. The strength reduction factors will reflect the degree of reliability and hence the level of structural performance of the house, as do the load factors stated in [A.5.1.7a](#)). The characteristic strength of a structure or a component is determined from the characteristic material strengths. It is therefore important to specify these and the test methods from which the characteristic strength are determined.

A.5.2.3 Resistance based on allowable stress criteria

The allowable stress criteria are described by stating the factor of safety, the characteristic material strengths and the method of testing from which the characteristic material strengths are determined. These require consultation between the specifier and the provider concerning material selection, in order that appropriate allowable stresses can be specified. Usually, the allowable stress value is equal to the characteristic material strength divided by the factor of safety. A factor of safety for overall stability consideration should also be selected.

A.6 Evaluation

A.6.1 General

The method required for evaluation should be indicated, usually a combination of analysis and testing. Since this part of ISO 15928 is concerned mainly with the description of performance, the actual criteria to be used in evaluation are not part of it and are included in this commentary for information only.

A.6.2 Analysis

The general principle for evaluation is that the action effect must be equal to or less than the available resistance. The evaluation can be carried out using either Limit State or Working Stress format depending on how the action effects and resistances are defined.

a) Limit State Design Format

For satisfactory structural safety performance, the house should meet both stability, and strength and deformation, criteria.

1) Stability

When considering a limit state of static equilibrium or of gross displacements or deformations of the structure, the criterion is

$$E_{st} > E_{dst}$$

where

E_{st} is the design effect of stabilizing actions which includes the factored stabilizing part of the permanent action and any design resistance;

E_{dst} is the design effect of destabilizing actions which includes the factored destabilizing parts of the appropriate actions.

2) Strength and deformation

When considering a limit state of rupture or excessive deformation of a section, member or connection, the criterion is

$$R_d > E_d$$

where

R_d is the design resistance;

E_d is the design action effect.

b) Working Stress Design Format

For satisfactory structural safety performance, the house must meet both stability and static strength criteria.

1) Stability

When considering the state of static equilibrium, the criterion is

$$E_{st} > E_{dst}$$

where

E_{st} is the design effect of stabilizing actions which includes the stabilizing part of the permanent action and any design resistance;

E_{dst} is the design effect of destabilizing actions which includes the destabilizing parts of the appropriate actions.

2) Strength

When considering the state of strength of a section, member or connection, the criterion is, at all points in the structure

$$F_{act} > F_{all}$$

where

F_{act} is the actual stress;

F_{all} is the allowable stress.

A.6.3 Testing

Testing may include the testing of the whole house or the testing of a specific component. Guidance for testing can be found in ISO 2394:2015, Annex D. Since most of the components in a house are not large,

full-scale testing is preferred. If prototype testing is used, consideration should be given to the effects of variability in the evaluation of the test results.

A.6.4 Service experience

Evaluation may be based on experience of similar cases and conditions or compliance with well-established solutions. The judgement should be as objective as possible by application of strict rules. The decision-making process, the procedure used, and the factors taken into account should be documented in such a way that this process can be reconstructed if necessary.

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Annex B (informative)

Structural safety performance checklist

B.1 Design method

- a) Limit State Design (LSD) ☐
- b) Allowable Stress Design (ASD) ☐

B.2 Design loads

B.2.1 Permanent loads other than self-weight

Magnitude (kN) (.....)

Location (show plan) (.....)

B.2.2 Imposed load (live load)

- a) Uniform floor or roof load
- uniformly distributed load (kPa) (.....)
- b) Concentrated floor or roof load
- concentrated (kN) (.....)
- over a specified area of (m²) (.....)
- c) Wall load
- impact load on walls (kN) (.....)
- applied height above the floor (m) (.....)
- d) Line load (for hand rails, etc.)
- horizontal line load (kN/m) (.....)
- applied height above the floor (m) (.....)

B.2.3 Wind load

Type of wind speed:

- a) 3-s gust ☐
- b) 1-min mean ☐
- c) 10-min mean ☐
- d) hourly mean ☐

Representative value of wind speed (m/s) (.....)