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Houses — Description of performance —

Part 2: Structural serviceability

Constructions d'habitation — Description des performances —

Partie 2: Aptitude au service de la structure

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 15928-2 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*

The following part is under preparation:

— *Part 3: Structural durability*

Introduction

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

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

NOTE World trade organisation (WTO) *Agreement on technical barriers to trade* (WTO 1997), Clause 2.8, states that "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 2: Structural serviceability

1 Scope

This part of ISO 15928 sets out a method for describing the structural serviceability performance of houses. This part of ISO 15928 covers user needs, 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 sub-systems, and in developing quality systems for houses.

This part of ISO 15928 does not apply to structural safety, durability or other attributes that 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 2394:1998, *General principles on reliability for structures*

ISO 4356:1977, *Bases for the design of structures — Deformations of buildings at the serviceability limit states*

ISO 10137:1992, *Bases for design of structures — Serviceability of buildings against vibration*

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 can be separated or linked horizontally, but not linked vertically, which has its own access and does not share any space in common with another building

3.2
ground movement
displacement in any direction of the founding stratum by influences not solely dependent on the actions applied by the housing carcass

3.3
load
value of a force corresponding to an action

3.4
parameters
⟨structural serviceability⟩ group of variables used to quantitatively describe the structural serviceability performance

NOTE Structural parameters consist of variables describing (i) magnitudes of the actions, (ii) magnitudes of structural response and (iii) other conditions that may affect the structural serviceability performance.

3.5
gitting
fixture, such as shelving, cupboards, equipment, etc., that is permanently fixed to the ceilings, walls, etc., of a house

3.6
performance
behaviour of houses related to users' needs

3.7
equipment
⟨hydraulic, mechanical electrical⟩ device that is provided for use within a house

3.8
component
part of a house that can be identified

EXAMPLE Floor, wall.

NOTE Includes fixtures.

3.9
structural serviceability performance
structural behaviour of a house for normal use under all expected actions that might affect the occupants and the functioning of the house

4 Structural serviceability performance

4.1 User needs

The following characteristics of a house, for normal use and conditions, under all expected actions, should be kept within levels acceptable to the user:

a) functioning and appearance of the house and its components;

b) functioning of the occupants in the house;

c) functioning of the equipment in the house;

d) comfort of the occupants;

e) asset value of the house.

NOTE The relative importance of each of these characteristics varies and is reflected in the performance requirements that are specified.

4.2 Performance description

The performance description is the ability of the whole house and its parts, with an appropriate degree of reliability, to perform within established parameters under all expected actions for normal use in terms of

a) local damage, including cracking, (which can affect the efficiency and appearance of the house and its components),

b) deformation (which can affect the efficient use or appearance of the house or the functioning of the people and equipments),

c) vibration (which can cause discomfort or affect the activity of occupants or the functioning of equipments).

NOTE 1 The appropriate degree of reliability can be judged with due regard to the possible consequences of serviceability failure and the expense level of effort and procedures necessary to reduce those 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 Expected actions for normal use can include those arising from soil/structure interaction, probable ground movements, compatibility of connections between subsystems and the effects of openings.

NOTE 3 For the purposes of this standard, the durability of materials is not considered to have a bearing on the structural serviceability performance of the house.

4.3 Principles describing structural serviceability performance

The structural serviceability performance can be described by the structural actions on the house under normal use and the structural responses under the effect of those actions. Only actions and responses relevant to serviceability issues of concern need to be described.

NOTE For design specification, it is necessary to nominate the levels of structural actions and the acceptable limits of the structural responses corresponding to those levels of actions.

5 Parameters for the description of performance

5.1 Parameters for describing action

5.1.1 Permanent actions

The permanent actions, other than self-weight, are described by the magnitude(s), expressed 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 the following:

a) uniformly distributed floor or roof load, expressed in kilonewtons per square metre:

b) concentrated floor or roof load, expressed in kilonewtons per: specified area, expressed in square metres;

c) concentrated wall impact load, expressed in kilonewtons, applied at a specified height, expressed in metres, above the floor;

d) uniformly distributed horizontal line load, expressed in kilonewtons per metre, applied at a specified height, expressed in meters, above the floor.

EXAMPLE A hand-rail.

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

5.1.3 Wind actions

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

a) 3 s gust;

b) 1 min mean (fastest mile);

c) 10 min mean;

d) hourly mean.

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

5.1.4 Seismic actions

Seismic actions are described by stating the representative value, under normal condition, of one of the following parameters:

a) effective peak ground acceleration, expressed as a fraction of gravity;

b) base shear coefficient;

c) horizontal force applied to the structure, in kilonewtons, and its location;

d) ground acceleration response spectrum for the site;

e) floor acceleration response (for equipment and fittings).

NOTE 1 Item e) relates to phenomena where equipment and/or fittings cannot be used due to the acceleration.

If either a) or b) is used, then 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 2 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, under normal conditions, of the following:

a) ground snow depth, expressed in metres, derived from the basic snow depth, factored to take into account local effects such as terrain, shielding, topography and the like;

b) snow density, expressed in kilograms per cubic metre, i.e., the density used in converting the ground snow depth into a load;

c) 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 Vibration sources

Consideration shall be given to the description of vibration sources inside and outside the house, such as that caused by machinery, vehicular traffic and human activity, if these sources affect the occupants of the house on a regular basis.

NOTE ISO 10137 [5] provides information on the description of vibration sources.

5.1.7 Impact sources

If these impacts are likely to occur during normal use, consideration shall be given to the description of impact sources due to human activities or the environment in terms of the following:

a) specified in mass, expressed in kilograms;

b) specified energy, expressed in joules;

c) type of impact (soft or hard body impact).

EXAMPLE Accidental human body impacts due to slip, trip and fall (soft body impact) and impacts of falling objects (hard body impact).

NOTE ISO 7892 [6] provides information on impact test on vertical building elements.

5.1.8 Actions derived from fittings

Consideration shall be given to the description of actions resulting from fittings in terms of a load, expressed in kilonewtons, at a specific location, such as on a ceiling, on a wall or at a distance from a wall.

EXAMPLE Examples of wall-mounted fittings are cupboards and mirrors, and of ceiling-mounted fittings, lights and fans.

NOTE Depending on the situation, an action arising from “fittings” can be categorized as, for example, the following:

a) imposed action;

b) vibration sources;

c) impact sources.

5.1.9 Other actions

Consideration shall be given to the description of other actions, if these actions are likely to affect the structural serviceability of the house.

5.1.10 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.

5.1.11 Ground conditions and movements

The ground conditions and movements are described by stating the following:

a) representative values of bearing capacity, either as an allowable or ultimate value, expressed in kilonewtons per square metre, for a given total and differential settlement, expressed in millimetres;

b) nature and magnitude of expected ground movements, expressed in millimetres, expressed both as a total surface movement and as a differential movement, arising from swelling, consolidation, shrinkage or settlement of the subsoil;

c) representative stiffness of the soil, expressed in millimetres per kilopascal;

d) diameter, expressed in metres, and location of any soft spot over which a loss of support to the house is likely to occur, or the distance from the perimeter of the house over which a loss of support is likely to occur.

5.2 Parameters for describing structural responses

5.2.1 General

For serviceability considerations, structural responses under the effects of the actions can be described in terms of parameters representing deformations, vibrations and local damages.

NOTE For design specification, structural serviceability limits under the effects of the actions can be described in terms of limiting values that are based on characteristic values and partial factors for materials. These values shall take into account of the variability of the material properties and the level of reliability for serviceability limit states and the frequency of the actions.

5.2.2 Deformation

5.2.2.1 Deflection

Deflections (vertically, horizontally, in-plane, out-of-plane, terminal and medial) are described in terms of the following:

a) deflection to span ratio or deflection over a defined length;

b) deflection to storey height ratio;

c) absolute value, expressed in millimetres.

NOTE 1 Deflection can also be use as a measure of rotation or curvature.

NOTE 2 ISO 4356 [7] provides information on deformation of buildings at the serviceability limit states.

NOTE 3 Deflection can be described as elastic deformation and/or permanent deformation (non-residual/residual).

Consideration should be given to long-term and short-term effects, e.g. creep.

5.2.2.2 Tilt

Tilting is described in terms of angular distortions.

5.2.3 Vibration

Vibration response is described in terms of the following:

a) frequency, expressed in hertz;

b) acceleration, expressed in metres per square second, velocity, expressed in metres per second, and displacement, expressed in millimetres.

NOTE 1 Refer to ISO 10137 for guidance on serviceability of buildings against vibration.

NOTE 2 Vibrations for the house as a whole and its parts can have different values.

5.2.4 Local damage

Local damage is described in terms of cracking and spalling:

a) cracking:

— approximate crack width, expressed in millimetres;

— location and frequency of cracks.

b) spalling:

— approximate spall depth, expressed in millimetres, and area, expressed in square metres;

— location and frequency of spalls.

5.2.5 Response to impact

Response to impact is described in terms of the following:

a) permanent deformation;

b) permanent displacement in terms of a deflection ratio;

c) crack width and aggregate crack length, expressed in millimetres;

d) puncturing;

e) Indentations or displacements, expressed in millimetres;

f) visible cracks of a given width and an aggregate length, expressed in millimetres.

5.2.6 Fittings

The performance of the house to support fittings is described in terms of the following:

a) its ability to support the actions specified in 5.1.8;

b) damage caused by the loosening and withdrawal of fixing devices.

6 Evaluation

6.1 General

Evaluation may be carried out by means of the following:

a) analysis;

b) testing;

c) service experience;

d) combination of the above.

NOTE For materials with recognized engineering properties, evaluation is usually carried out by analysis using appropriate norms and standards.

6.2 Analysis

The assessment of distortions and vibrations of 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.

6.3 Testing

Testing shall incorporate a realistic representation of materials, loading conditions, boundary conditions and construction practices. Testing for evaluating structural serviceability shall be full-scale.

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 General

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

The clause and subclause numbers in parentheses in A.2 to A.6.4 indicate the clause and subclause numbers in the main text of this part of ISO 15928.

Details on references and documents referred to in notes in this part of ISO 15928 and in Annex A are provided in a Bibliography at the end of the document.

A.2 Comments on Scope (Clause 1)

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

It is one of a series of parts of ISO 15928 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 is to be used to realise performance description.

The objectives of the standard 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 may also be useful in increasing consumer product awareness and in developing quality systems for houses.

A.3 Comments on Terms and definitions (Clause 3)

In general, the adopted definitions are those given in ISO 6240 [7], ISO 6241 [8] with regard to performance and ISO 2394 with regard to structural terms, except for the following terms that require further elaboration.

A.3.1 Action and load: the term “action” is used to indicate an agent that affects the structural performance and the term “load” is used when the action is quantified.

A.3.2 Design value of an action: the value obtained by multiplying the representative value by the appropriate load factor.

A.3.3 Representative value of an action: the value used as reference for the description of performance.

NOTE ISO 2394 defines representative value as “the values used for verification of a limit state that consist of characteristic values, combination values but may also consist of other values”.

A.4 Comments on Structural serviceability performance (Clause 4)

A.4.1 Comments on User needs (4.1)

The user’s needs for structural serviceability are thought of in terms of the structural behaviour that might affect the functioning of the house, the comfort of the occupants and the appearance of the house. These problems can be caused by environmental agents, such as wind, earthquake, etc., or human activity, such as walking, running, etc. These problems can affect the occupants, the contents of the house or the structure of the house. There are other amenity issues that are not part of structural serviceability, such as noise, light, indoor air quality, etc.

For simplicity, the term “action” is used in this part of ISO 15928 with the same meaning as in Part 1 of the series. Actions caused by human activities can be described using “impact sources” or “vibration sources”.

The relative importance of various serviceability issues can differ according to the difference in culture and living habits of various countries as well as the types of housing provided. The user needs are, therefore, identified by respective countries and/or regions according to their own perceived needs.

A.4.2 Comments on Performance description (4.2)

Serviceability is considered in relation to local damage (including cracking), deformation and vibration of the structure, as these parameters are affected by structural behaviour. The structural safety and durability characteristics, including maintenance, are considered in separate standards.

The expected actions under normal use refer to the values of actions that have a high probability of occurrence. For example, the serviceability values for wind action are normally expressed in terms of 10-year to 20-year return periods (0,1 to 0,05 annual probability of exceedance), in contrast to the ultimate values of 500-year to 1 000-year return periods (0,002 to 0,001 annual probability of exceedance).

Consideration should also be given to the reversible or irreversible nature of the structural responses. For example, local damage such as cracking is usually irreversible while elastic deformation under wind load is normally reversible.

A.4.3 Comments on Principles for describing structural serviceability performance (4.3)

The specifier first nominates a representative value for each of the actions and other parameters that affect serviceability performance. The representative value is normally a characteristic value. This value together with the load factor describes the load level to be used in design. For example, the specifier may choose to select a 20-year return value as the representative value for wind action and a load factor of 1,0 for serviceability. Alternatively, the specifier may choose a 50-year return value as the representative value and a load factor of, say, 0,7 for serviceability. The specifier then selects a limiting value for the structural response that is considered to be acceptable under the effect of the specified action.

Table A.1 illustrates the relationship among 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, parameter, representative and design values

Agent	Performance parameter	Representative value of the action	Design value for serviceability	Limiting value of structural response
Imposed actions	Q (kPa or kN)	Q	$\gamma_Q \cdot Q$	Vertical deflection
Wind actions [a]	V (m/s)	W_{20}, W_{50}	$\gamma_W \cdot W_{50}$ or W_{20}	Sway
Seismic actions [b]	a (m/s^2)	E_{50}, E_{100}	$\gamma_E \cdot E_{100}$, or E_{50}	Storey drift
Snow actions [c]	D_G, ρ (kg/m^3)	S_{20}	$\gamma_S \cdot S_{20}$	Vertical deflection

[a] W_{20}, W_{50} are the 20 year and 50 year return values for the wind load, respectively.

[b] E_{50}, E_{100} are the 50 and 100 year return values for the seismic load respectively.

[c] S_{20} is the 20 year return value for the snow load.

A.5 Comments on Parameters for the description of performance Clause 5

A.5.1 Comments on Parameters for describing actions (5.1)

Clause 5 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 can use different parameters for the description of the actions; these can still be used, provided that they can be converted into the parameters adopted in this part of ISO 15928.

A.5.2 Comments on Permanent actions (5.1.1)

Subclause 5.1.1 is intended for specific permanent loads that need to be specified, e.g. water tank, chandelier. Their exact locations should also be specified.

A.5.3 Comments on Imposed actions (5.1.2)

ISO 2103 [1] provides representative values for minimum recommended imposed loads for different types of use and occupancy. There is no ISO International Standard for specifying impact load at present but there are ISO International Standards for impact testing (ISO 7892) [6].

A.5.4 Comments on Wind actions (5.1.3)

Wind speed has been chosen as the parameter to represent wind action. The alternative is 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, shielding, etc. 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 [2] provides the conversion factor between different types of wind speed as well as the process to convert wind speeds into wind forces.

A.5.5 Comments on Seismic actions (5.1.4)

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 [3].

A.5.6 Comments on Snow actions (5.1.5)

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, etc. 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. The approach is consistent with ISO 4355[4].

A.5.7 Comments on Vibration sources (5.1.6)

The description of the characteristics of vibration sources is a difficult problem. ISO 10137[5] contains many recommendations on how to describe dynamic actions from various sources.

A.5.8 Comments on Impact sources (5.1.7)

ISO 7892[6] contains recommendations for three types of impact: hard bodies, small soft bodies and large soft bodies. It also contains general test procedures for these types of impact. The specifier should select from ISO 7892 the most appropriate test to suit his needs and the corresponding criteria for acceptance. The performance level can be specified in terms of energy levels (without causing cracking, permanent indentation or collapse). Other types of impact, such as the slamming of a door, are not covered in ISO 7892 and might need to be addressed separately.

A.5.9 Comments on Fittings (5.1.8)

Walls and ceilings should be able to support the fittings such as light fittings, coat hooks, towel rails, cabinets, cupboards, shelving, etc. at the specified location. Lightweight fittings are not likely required to support the weight of a person but heavy fittings are expected to do so.

A.5.10 Comments on Other actions (5.1.9)

Other actions, such as floods, might need to be specified if they are frequently occurred problems.

A.5.11 Comments on Combination of actions (5.1.10)

The combinations of actions will be dependent on the chosen design criteria. Distinction should be made between short-term and long-term effects.

For example, the following load combinations are normally considered:

a) long-term combinations:

— G

— $G + \Psi_1 Q + (S)$

b) short-term combinations:

— (W_s or E_s)

— $G + \Psi_s Q$

where

E_s is the serviceability seismic load;

G is the permanent (dead) load;

Q is the imposed (live) load;

$\Psi_l Q$ is the long-term component of imposed load;

$\Psi_s Q$ is the short-term component of imposed load;

S_s is the serviceability snow load;

W_s is the serviceability wind load.

A.5.12 Comments on Ground conditions and movements (5.1.11)

This parameter mainly affects the design of the foundation but can have consequences on the overall performance such as settlement.

The sensitivity of the soil to moisture changes can affect only certain types of construction such as slab on ground.

A.5.13 Comments on Parameter for describing structural response (5.1.12)

The structural response relating to structural serviceability is described in terms of criteria for deformation, vibration, local damage, response to impact and fittings.

Structural serviceability conditions can be either of a reversible or non-reversible nature and therefore it is necessary to establish different criteria for each type. For reversible serviceability condition, the criteria may involve unacceptable exposure time or frequency.

Design for serviceability involves considerable engineering experience and subjective judgment. Specific quantified limits do not always ensure satisfactory in-service behaviour and should be considered only as a guide to design.

A.5.14 Comments on Deformation (5.1.13)

Deformation limits should be set to control the following:

a) deformations affecting appearance, such as visible sag of floors and ceilings and visible leaning of walls and columns;

b) deformations affecting use such as curvature and slope of floors;

c) deformations associated with oscillations generated by wind and earthquake forces.

Table A.2 is a summary as to what behaviour can be expected at different levels of deformation under static loads.

Table A.2 — Expected behaviour at different levels of deformation under static loads

Deformation [a]	Visibility	Typical behaviour
L/2000	Not visible	Cracking of brittle materials subjected to hogging movements
L/1000	Not visible	Cracking of brittle materials subjected to sagging movements
H/500	Not visible	Cracking of partition walls, general architectural damages
L/300, H/300	Visible	Cracking in walls, damage to ceiling and flooring, cladding leakage, visually objectionable
L/200 to L/300 H/200 to H/300	Visible	Damage to light weight partitions, windows, finishes
L/100 to L/200 H/100 to H/200	Visible	Impaired operation of moveable components: doors, windows, sliding partitions

[a] L = span of horizontal member; H = Storey height.

A.5.15 Comments on Vibration (5.1.14)

Vibration due to human activities can be controlled by specifying the limiting dynamic characteristics of the system or by its equivalent static properties such as stiffness and deformation.

A.5.16 Comments on Local damage (5.1.15)

When specifying limits on cracking, consideration should be given to the type of building materials involved, the nature of the cracks (through cracks or surface cracks), their reparability and capability of being covered by decoration. For example, damage with reference to walls and floors can be classified as in Table A.3.

Table A.3 — Example of a general guide for masonry structures

Description of typical damage with reference to walls	Approximate crack width limit mm
Hairline cracks	0,1
Fine cracks that do not need repair	1
Cracks noticeable but easily filled. Doors and windows stick slightly	5
Cracks can be repaired and a small amount of wall may need to be replaced. Doors and windows stick. Service pipes may fracture. Weather tightness often compromised.	Single cracks, 5 to 15; or a number of cracks in a group, 3 or more
Extensive repair work involving replacing sections of walls, specially over doors and windows. Door and window frames distort. Walls lean and bulge noticeably. Service pipes disrupted.	15 to 25
Description of typical damage with reference to floors	
Hairline cracks	0,3
Fine but noticeable cracks; slab reasonably level	1
Distinct cracks; slab noticeably curved or change in level	2
Wide cracks; obvious curvature or change in level	2 to 4
Gaps in slab; disturbing curvature or change in level	4 to 10

A.5.17 Comments on Response to impact (5.1.16)

If an impact test is specified, then criteria for acceptance of the test results should also be specified in terms of damages (e.g. indentation, cracks or other structural consequences).

A.6 Comments on Evaluation (Clause 6)

A.6.1 Comments on General (6.1)

The specifier shall indicate the method required for evaluation, 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 this part of ISO 15928 and are included in Annex A for information only.

A.6.2 Comments on Analysis (6.2)

When considering deformation, the criterion is

$$\delta < \delta_1$$

where

δ is the value of the serviceability parameter determined on the basis of the design action;

δ_1 is the limiting value of the serviceability parameter.

A.6.3 Comments on Testing (6.3)

Testing may include the testing of the whole house or the testing of a specific component. Guidance for testing may be found in ISO 2394:1998, 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 Comments on Service experience (6.4)

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.

Annex B
(informative)

Structural serviceability examples

Table B.1 — Structural serviceability examples

Component	Serviceability issue		Serviceability description	
	Problem	Consequence	Action	Control parameter
Whole House	Side sway	Damage neighbouring properties	Wind action Seismic action	Limits on lateral deflection at eaves
	Foundation settlement	Damage to cladding due to differential deformation. Deviation from vertical Crack or gaps between wall and ceiling/floor interface.	Permanent action Soil properties	Limits on differential deformation between components
Roof system				
Metal roofing	Indentation	Permanent surface damage	Weight of person walking on roof Hail impact	Limits on residual deformation Limits on visual defects when viewed from a particular distance
Tile roofing	Cracking	Permanent damage which can lead to water penetration and other problems	Weight of person walking on roof Hail impact	Limits on differential deflection of the supporting elements Limits on width of cracking
Structural Elements	Sag	Unsightly deformation of cladding	Permanent action	Limits on maximum deflection between supports
Ceiling	Deflection between supporting points	Unsightly ripple effect Cracking of plaster finish	Permanent action	Limits on maximum deflection between supports
Flat roof	Out of flatness	Ponding, drainage	Permanent action Snow/ rain action	Limits on maximum deflection between supports
Wall system	Sagging of lintels	Door/window jamming Buckling of facia	Gravity action	Limits on maximum vertical deflection between supports
	Flexible wall (out of plane)	Discernable movement Damage to brittle fixing (e.g. ceramic tiles) Cracking of plaster Damage to glazing system, windows, façade, curtain walls	Wind action Seismic action	Limits on maximum horizontal deflection between supports
	Indentation	Permanent surface damage	Accidental action	Control test (ISO)
	In plane racking deformation	Cracking of plaster Cracking of masonry/concrete walls Glass damage	Wind action Seismic action	Limits on racking panel deformation

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