
**Bases for design of structures — General
requirements**

Bases du calcul des constructions — Exigences générales

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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

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 22111 was prepared by Technical Committee ISO/TC 98, *Bases for design of structures*, Subcommittee SC 2, *Reliability of structures*.

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Introduction

This International Standard incorporates the general principles of structural design set out in ISO 2394. It covers the partial factors method, and ISO 2394 should be consulted for other methods.

This International Standard is relevant to the design of any structure, and as with all standards, a degree of judgement should be used in the normal course of engineering.

It has been drafted with wording and format suitable for direct use by practising engineers when the appropriate levels of safety have been chosen, and the relevant national loading and materials standards referenced by National Authorities. It is a template intended to facilitate the widespread use of International Standards.

The annexes give guidance on adoption of this International Standard but need not be included in the National Standard.

This International Standard has the following aims.

- a) To facilitate international practice in structural design.
- b) To obtain international standardization of the process for setting up rules for structural design, while allowing each economy to specify its own levels of structural performance, in accordance with its own needs.
- c) To provide a means of promoting commonality, interchangeability, consistency and comparability of structural standards developed by different economies. Regulators, standards writers, designers and academics could then adopt such standards with confidence in their international acceptance.
- d) To encourage regulatory authorities in each country to describe their mandatory requirements in an internationally agreed format.
- e) To facilitate future coordination between the various specialist subcommittees and working groups for ISO structural Standards.
- f) To create transparency in the process of comparison of National Standards.

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Bases for design of structures — General requirements

1 Scope

This International Standard specifies the general requirements for the structural design of buildings and industrial and civil engineering structures using reliability-based concepts.

This International Standard is applicable to the design of complete structures, the structural elements making up the structure and the foundation. Information on the assessment of existing structures is given in ISO 13822.

To allow for the differences in design practice between different countries, certain parameters are left to be quantified by national building codes or standards.

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*

<https://standards.iteh.ai/catalog/standards/sist/a1ce0cb0-1ab3-4805-bae9-178949e3e7e8/iso-2394-1998>

ISO 3898:1997, *Bases for design of structures — Notations — General symbols*

ISO 8930:1987, *General principles on reliability for structures — List of equivalent terms*

ISO 13822:2001, *Bases for design of structures — Assessment of existing structures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8930 and the following apply.

3.1

accidental action

action that is unlikely to occur with a significant value on a given structure over a given reference period

NOTE Adapted from ISO 8930:1987.

3.2

accompanying action

for a particular combination of actions, an action taken as being at a reduced value with respect to its maximum extreme design value

3.3

characteristic value of an action

principal representative value of an action

NOTE 1 Adapted from ISO 8930:1987.

NOTE 2 It is chosen

- a) either, when a statistical basis is available, so that it can be considered to have a prescribed probability of not being exceeded (towards unfavourable values) during a reference period, or
- b) on acquired experience, or
- c) on physical constraints.

3.4 combination value of a variable action

value chosen, insofar as it can be determined on a statistical basis, so that the probability that the effects caused by the combination will be exceeded is approximately the same as by the characteristic value of an individual action

NOTE 1 It may be expressed as a certain part of the characteristic value by using a factor $\psi_0 \leq 1,0$.

NOTE 2 Adapted from ISO 8930:1987.

3.5 deformability

deformability is the capacity to resist displacement-based actions

NOTE Examples of displacement-based actions are indirect actions such as seismic ground motions, differential settlement and volume changes in structural materials.

3.6 design situation

set of conditions under which the design is required to demonstrate that relevant limit states are not exceeded during a specific time interval

NOTE Adapted from ISO 2394:1998.

3.7 design working life

duration of the period during which a structure or a structural element, when designed, is assumed to perform for its intended purpose with expected maintenance but without major repair being necessary

NOTE Adapted from ISO 2394:1998.

3.8 direct action

set of concentrated or distributed forces acting on the structure

[ISO 8930:1987]

3.9 durability

ability of a structure or a structural element to maintain adequate performance for a given time under expected actions and environmental influences

3.10 dynamic action

action which causes significant accelerations of the structure or structural members

[ISO 8930:1987]

3.11 fixed action

action which has a fixed distribution on a structure, such as its magnitude and direction, determined unambiguously for the whole structure when determined at one point on the structure

NOTE Adapted from ISO 8930:1987.

3.12**free action**

action which may have any distribution in space over the structure, within certain limits

[ISO 8930:1987]

3.13**frequent value of a variable action**

value determined, insofar as it can be determined on a statistical basis, so that either the total time, within the reference period, during which it is exceeded is only a small part of the reference period, or the frequency of it being exceeded is limited to a given value

NOTE 1 It may be expressed as a determined part of the characteristic value by using a factor $\psi_1 \leq 1,0$.

NOTE 2 Adapted from ISO 8930:1987.

3.14**indirect action**

set of deformations or accelerations imposed on a structure or constrained within it

NOTE Adapted from ISO 8930:1987.

3.15**leading action**

for a particular combination of actions, the action that is taken to be at its maximum extreme design value

3.16**limit states**

states beyond which a structure no longer satisfies the design requirements

[ISO 8930:1987]

NOTE These boundaries between desired and undesired performance of the structure are often represented mathematically by "limit-state functions".

3.17**maintenance**

total set of activities performed during the design working life of a structure to enable it to fulfil the requirements for reliability

[ISO 2394:1998]

3.18**occupancy action**

variable action imposed on the structure due to the intended use or occupancy of the structure

3.19**partial factors format**

calculation format in which allowance is made for the uncertainties and variabilities assigned to the basic variables by means of representative values, partial factors and, if relevant, additive quantities

[ISO 2394:1998]

NOTE The load and resistance factor format is a version of the partial factor format.

3.20**permanent action**

action which is likely to act throughout a given reference period of time, and for which the variation in magnitude with time around its mean value is negligible, or for which the variation is monotonic (i.e. always in the same direction) until the action attains a certain limiting value

NOTE Adapted from ISO 8930:1987.

3.21

quasi-permanent value of a variable action

value determined so that the total period of time for which it is exceeded is a large fraction of the reference period

NOTE 1 It may be expressed as a determined part of the characteristic value by using a factor $\psi_2 \leq 1,0$.

NOTE 2 Adapted from ISO 8930:1987.

3.22

reference period

chosen period of time that is used as a basis for assessing the design value of variable or accidental actions or both

NOTE Adapted from ISO 8930:1987.

3.23

reliability

ability of a structure or structural element to fulfil the specified requirements, including the design working life, for which it has been designed

[ISO 2394:1998]

3.24

representative value of an action

value assigned to the action for a specific purpose

NOTE 1 Adapted from ISO 8930:1987.

NOTE 2 It can be used, for instance, for the verification of a limit state.

3.25

robustness

ability of a structure (or part of it) to withstand events (like fire, explosion, impact) or consequences of human errors, without being damaged to an extent disproportionate to the original cause

NOTE 1 Adapted from ISO 2394:1998.

NOTE 2 Robustness is sometimes referred to as structural integrity.

3.26

strength

ability of a cross-section or an element of a structure to withstand actions without mechanical failure

EXAMPLES Bending strength, buckling strength, tension strength.

3.27

serviceability limit states

states corresponding to conditions beyond which specified serviceability requirements for a structure or structural element are no longer met

NOTE 1 Adapted from ISO 2394:1998.

NOTE 2 They are related to the user's comfort, function of the structure or element, risk of deterioration, or intended maintenance.

3.28

static action

action that does not cause significant acceleration of a structure or a structural element

NOTE Adapted from ISO 8930:1987.

3.29**structural model**

idealization of the structural system used for the purposes of analysis, design and verification

[EN 1990:2002]

3.30**ultimate limit states**

states associated with collapse, or with other similar forms of structural failure

NOTE They generally correspond to the maximum load-carrying resistance of a structure or structural element but in some cases to the maximum applicable strain or deformation.

[ISO 2394:1998]

3.31**variable action**

action for which the variation in magnitude with time is neither negligible in relation to the mean value nor monotonic

NOTE Adapted from ISO 8930:1987.

4 Symbols

The symbols used in this International Standard follow the guidelines given in ISO 3898 and ISO 2394.

A :	accidental action (standards.iteh.ai)
A_d :	design value of a leading accidental action (see Annex B)
C_d :	serviceability limit; see Equation (5)
E_d :	design-action effect
$E_{d,destab}$:	design effect of destabilising actions
$E_{d,stab}$:	design effect of stabilising actions
F :	action in general
F_i, F_j :	various actions
G :	permanent action
G_i :	permanent action for a particular combination
$G_{ki,stab}$:	the component of the permanent action that is relied upon to stabilise the structure (see 9.2.2)
G_k :	characteristic value of permanent action (see Annex B)
$G_{k,i}$:	characteristic permanent action for a particular combination (see 9.2.1)
$G_{kj,inf}$:	lower characteristic value of permanent action (see Annex B)
$G_{kj,sup}$:	higher characteristic value of permanent action (see Annex B)

Q :	variable action
Q_k :	characteristic value of a variable action in a combination
$Q_{k,1}$:	characteristic value of a leading variable action (see 9.2.1)
$Q_{k,i}$:	characteristic value of an accompanying variable action (see 9.2.1)
R_d :	design resistance
R_s :	design resistance of the restraining elements (if any)
β :	reliability index (beta)
$\beta_I, \beta_{II}, \beta_{III}, \beta_{IV}$:	values of reliability index appropriate to various consequence levels
γ :	partial factor (gamma)
$\gamma_{a,i}$:	factor applied to the characteristic action to determine the accompanying action (see B.2)
γ_i :	partial factor of the accompanying variable action
γ_j :	partial factor for leading variable or accidental action
γ_m :	partial material factor
$\gamma_{Gi,stab}$:	the load factor for the permanent action that is relied upon to stabilise the structure
$\gamma_{Gj,inf}$:	factor for the lower combination value of a permanent action (see Annex B)
$\gamma_{Gj,sup}$:	factor for the higher combination value of a permanent action (see Annex B)
γ_G, γ_{Gi} :	partial factors for various permanent actions
γ_{Qi} :	factor for combination value of an accompanying variable action (see Annex B)
$\gamma_{Q,1}$:	factor for combination value of a leading variable action (see Annex B)
ψ_i :	factor for combination value of a particular action (psi)
ψ_0 :	factor for combination of a variable action
ψ_1 :	factor for frequent value of a variable action (see Annex B)
ψ_2 :	factor for quasi-permanent value of a variable action (see Annex B)
$\psi_{2,1}$:	factor for quasi-permanent value of a leading variable action (see Annex B)
$\psi_{2,i}$:	factor for quasi-permanent value of an accompanying variable action (see Annex B)
ϕ :	resistance factor
ξ :	reduction factor for unfavourable permanent actions (see B.1)