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Bases for design of structures — Names and symbols of physical quantities and generic quantities

Bases du calcul des constructions — Noms et symboles des grandeurs physiques et grandeurs génériques

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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 3898 was prepared by Technical Committee ISO/TC 98, *Bases for design of structures*, Subcommittee SC 1, *Terminology and symbols*.

This fourth edition cancels and replaces the third edition (ISO 3898:1997), which has been technically revised.

The main reasons for this fourth edition of ISO 3898 are

— application of new techniques and methods in the analysis and design of structures, e.g. probabilistic and partial factor methods, introduction of codes for new design situations, and more advanced materials have increased the need for a more fundamental set of rules for the formation and presentation of symbols, and

— revisions of the ISO Guide 31 series for the International System of Units (S.I.).

The major technical changes from the previous edition are the following:

— the normative references have been updated; particularly with regard to the ISO 80000 series;

— the so-called ‘kernel-index-method’ for forming and writing names and new (compound) symbols is presented;

— the presentation of the (tables of) indices has been altered in accordance herewith;

— the concept of ‘generic quantities’ is introduced (Annex A).

0 Introduction

0.1 The concept of a ‘physical quantity’

The concept of a ‘physical quantity’ is, according to ISO/IEC Guide 99, defined by the following descriptive statement: an attribute of a phenomenon, body or substance that can be distinguished qualitatively and determined quantitatively.

The concept ‘physical quantity’ is designated by a name [= a verbal designation of an individual concept (see 3.4.2 of ISO 1087-1:2000)] and a corresponding symbol.

A physical quantity is characterized by its unique dimension. The dimension of a physical quantity is expressed in units (of measurement).

NOTE 1 According to the ISO/IEC Directives, Part 2 for drafting International Standards, SI units are applied.

NOTE 2 Physical quantities can be dimensionless, e.g. often the case with factors. In that case their dimension is noted as 1.

The names and symbols of the most important physical quantities (according ISO/IEC Guide 99: physical quantities in a general sense) - and their characterizing units - within the field of physical sciences and technology are given in ISO 80000-1. However, this is a limited set of names and symbols.

0.2 General method for forming and writing names and symbols of physical quantities

The names and symbols of the most important physical quantities (and their units) within the field of the design of structures are given in this document: see the Tables 2 to 4 of this International Standard (but necessarily there will/must be some overlap with ISO 80000-1).

This set of names and symbols is also limited, but with the help of the method given in this International Standard (*kernel-index-method*) the user will be able to form/compose new and unique (compound) symbols for a wide variety of physical quantities (according ISO/IEC Guide 99: particular physical quantities).

Adapted ‘reading’ of the compound symbols moreover enables the user to designate and particularize the corresponding unique names of the physical quantities (see examples in 3.2.2.5 and 3.2.2.8).

The method itself is presented/worked-out in 3.1 of this International Standard, the kernel of a compound symbol is given in or has to be chosen from the above mentioned Tables 2 to 4 and the indices forming that unique (compound) symbol (mostly subscripts) are given in or have to be chosen from Tables 5 to 10.

Bases for design of structures — Names and symbols of physical quantities and generic quantities

1 Scope

This International Standard covers physical quantities in a general sense. The kernel-index-method enables to form (compound) symbols of physical quantities related to a particular material and/or a particular technical field of design of structures.

It also gives the main names, symbols, and units for physical quantities within the field of design of structures.

Annex A in a general sense covers 'generic quantities' which are genuine to this field. The kernel-index-method can likewise be applied.

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 80000-1, *Quantities and units — Part 1: General*

ISO 80000-2, *Quantities and units — Part 2: Mathematical signs and symbols to be used in the natural sciences and technology*

ISO 80000-3, *Quantities and units — Part 3: Space and time*

ISO 80000-4, *Quantities and units — Part 4: Mechanics*

3 Names and symbols for physical quantities and units

3.1 General rules and method for forming and writing names and symbols

The kernel of a (compound) symbol can be chosen from Tables 2, 3 and 4 and indices (mostly subscripts) forming that unique (compound) symbol can be chosen from Tables 5 to 10.

NOTE 1 The rules are mainly adopted from the ISO 80000 series. In 3.2 the 'kernel-index-method' (KIM) has been formulated for the first time in an ISO International Standard. The method stems from the mathematical disciplines: Riemannian geometry and Affinor/Tensor analysis (Second half of nineteenth century).

NOTE 2 ISO 10241 can be used as a basis for formulating the correct name and definition of terms and quantities.

3.2 Rules and method for forming and writing names and symbols of physical quantities

3.2.1 Names

The name (in general) of a general physical quantity is (mostly) one term, being a noun, written in Latin lower case letter symbols in Roman (upright) type.

For several systems of physical quantities the names (and the symbols) of some physical quantities in a general sense are given in the ISO 80000 series. For the design of structures the system of physical quantities in a general sense is given in the Tables 2, 3 and 4 of this International Standard.

In case of the name of a new or a particular physical quantity a new name/term can be chosen/composed, for instance, by combining the name of an already existing physical quantity with all kinds of other terms.

For some terms like: coefficient, factor, parameter, number, ratio, level and constant, some guidance for applying them is given in ISO 80000-1.

EXAMPLE 1 One term of a physical quantity: area, thickness, force, strength, factor, etc.

EXAMPLE 2 A combination of (one of the above mentioned terms with other) terms:

— maximum area, nominal thickness of a flange, design value of a force,

— admissible (value of the) strength of timber in direction *x*, friction factor, etc.

3.2.2 Symbols

The following applies to the forming and notation of symbols:

3.2.2.1 The symbol of a physical quantity is a one-letter symbol, the kernel, written in italic type.

NOTE There is one exception: a characteristic number has two letter symbols, see ISO 80000-11.

3.2.2.2 A letter symbol for a kernel can be a lower case or an upper case letter symbol of the Latin or the Greek alphabet (see Tables 2, 3 and 4). In most cases the choice for a kernel of a physical quantity shall be based on considerations of dimension or the main usage, as given in Table 1 of this International Standard. A dimension or a main usage of a physical quantity not included in Table 1 shall comply the nearest appropriate category listed.

3.2.2.3 The kernel may be modified by applying one or more subscripts/indices (and sometimes superscripts), a so-called: compound symbol.

3.2.2.4 Subscripts/indices may be formed from letter symbols, digits and graphical symbols: they are written in Roman (upright) type. If the kernel of a physical quantity is used as a subscript/index it is written in italic type. Several kinds of subscripts/indices are given in the Tables 5 to 10.

3.2.2.5 A subscript/index is placed at the bottom right position of the kernel. By applying more than one subscript/index (sometimes superscript) the distinct indices should preferably be separated by a semi-colon (;). In the case of simple and clear, distinctive index symbols also a space or comma (,) is allowed. For simply two or three of these index symbols no separation at all may be appropriate.

NOTE Other positions, e.g. at the upper right, are possible too. However, in general these positions are reserved for other applications.

EXAMPLES

F_{ext}	external force;
K_{nom}	nominal (value of) external couple;
N_x, V_y, V_z	normal and shear forces in a cross-section of a beam;
M_y, M_z, T_x	bending and torsional moments in a cross-section of a beam;
m_{xx}, m_{yy}, m_{xy}	internal bending and torsional moments per length in a plate or shell;
w_{ser}	serviceability limit (state) of deflection;
f_u	ultimate limit (state) of strength;
ε_x, $1/2\gamma_z$, ε_y	two-dimensional normal and shear strains in general;
γ_R	partial factor for the transfer of material properties, geometry of structure and actions into resistance of structure;
γ_S	partial factor for the transfer of actions, geometry of structure and material properties into response of structure;
v_{sat}	humidity per volume at saturation.

3.2.2.6 By applying more than one subscript/index, the order of the subscripts/indices is from right to left as follows (if necessary/relevant the same rules can be applied for superscripts):

General format (***K***: kernel of a physical quantity, **vi** to **i**: indices):

$K_{vi;v;iv;iii;ii;i}$

index i): subscripts/indices related to probabilistic and partial factor methods of analysis and design;

EXAMPLES rep(resentative), nom(inal), k (characteristic), d(esign), etc.;

index ii): subscripts/indices related to types of limit state;

EXAMPLES u(ltimate), ser(viceability), fat(igue), fi(re), etc.;

index iii): subscripts/indices related to various aspects;

EXAMPLES g(uaranteed), max(imum), obs(erved), *i*, *j* (ordinal numbers), etc.;

index iv): subscripts/indices related to the Basic variables and the Performance functionals. The preferred order is: first the indices ‘S’, ‘s’ and ‘R’, ‘r’, then the other indices iv).

EXAMPLES

Basic variables:

F:	f	(Action in general, Loadcase), a(ccidental), g (permanent), sn(ow),etc.;
GE:	ge	(Geometry of structure in general);
M:	m	(Material property in general), el(asticity), cr(eepiness), etc.;

Performance functionals:

S: s (Response of structure, Sequel or Effect of action(s), Action-effect), dyn(amical), sli(ding), etc.;
NOTE Sometimes deviating from S, the symbol E is used, e.g. in a number of Eurocodes, and erroneously in ISO 22111:2007.

R: r (Resistance of structure, Capacity), frac(tional), fat(igue), etc.

index v): subscripts/indices related to (1) place, then to (2) direction;

EXAMPLES 1 (joint, knot, point, foundation) A, B, C, ..., a, b, c, ..., 1, 2, 3, ..., etc.;

EXAMPLES 2 x, y, z, //, etc.

index vi): subscripts/indices related to types of material;

EXAMPLES c(oncrete), ma(sonry), etc.

3.2.2.7 If, by applying the subscripts/indices i to vi (or superscripts), the dimension of the original physical quantity does not change, so $< K > = < K_{\mathrm{index}} >$, such subscripts/indices are called descriptive subscripts/indices (or superscripts).

3.2.2.8 A (compound) symbol is written without a final full stop (except for normal punctuation).

EXAMPLES

physical quantities with names with one term	**symbol**
area	A
thickness	t
force	F
strength	f
factor	μ

physical quantities with names as a combination of terms	**symbol**
maximum area	A_{max}
nominal thickness of a flange	$t_{\mathrm{fl;nom}}$
design (value of a) force	F_{d}
admissible (value of the) strength of wood in direction x	$f_{\mathrm{ti};xx;\mathrm{adm}}$
friction factor	μ_{fric}

NOTE For the equivalent rules in the case of generic quantities reference here is made to A.4.3.

3.3 Rules for forming and writing names and symbols of units

NOTE This International Standard adopts (the rules of) the International System of units (SI).

3.3.1 Names

All names are given in ISO 80000-1. The names are written in Latin lower case letter.

EXAMPLES

(7) base units:	metre, kilogram, second, ampere, kelvin, mole and candela;
(18+3) derived units:	newton, pascal, radian, etc.;
(20 prefixes for) multiples of units:	(multiple:) megapascal, etc.; (sub-multiple:) millimetre, etc.;
compound units:	newton metre, metre per second, etc.

3.3.2 Symbols

The symbol of a unit is only (a kernel of) one or more successive separate (mostly) Latin lower and/or upper case letter symbols, written in Roman (upright) type (irrespective of the type used in the rest of the text).

EXAMPLES m, K, kg, s, N, Pa, rad, MPa, mm, etc.

No subscripts (and superscripts) are allowed.

The symbol of a compound unit: a multiplication is indicated by one space or a half-high dot and a division can be indicated by a solidus (/).

EXAMPLES N·m or N m, m/s or m s^{-1}, etc.

A (compound) symbol is written without a final full stop (except for normal punctuation) and shall be placed after the numerical value, leaving a space between that value and the unit symbol.

EXAMPLE F = 10,8 kN, etc.

3.4 Additional rules for forming of symbols

3.4.1 Symbols of physical quantities

3.4.1.1 Subscripts/indices

In most cases a subscript/index may be selected from the Tables 5 to 11. If other subscripts/indices (or superscripts) are used a clear definition of their meaning shall be given.

3.4.1.2 Precautions

In preventing confusion the following precautions shall be taken:

— where there is a possibility of confusing 1 (numeral) with l (letter symbol), the letter symbol L or ℓ shall be used in place of the letter symbol l;

— the Latin upper case letter symbol O shall not be used as a main letter symbol owing to the possibility of confusion with the numeral 0 (zero). The Latin lower case letter symbol o may, however, be used as a subscript/index with the same meaning as the numeral 0 (zero);

— the Greek lower case letter symbols iota (ι), omicron (o) and upsilon (υ) shall not be used owing to the possibility of confusing them with various Latin letter symbols. For the same reason, it is recommended to avoid, as far as possible, the use of the Greek lower case letter symbols kappa (κ) and chi (χ). If the Greek lower case letter symbols eta (η), mu (μ) and omega (ω) are used, care must be taken in writing these letter symbols to avoid confusion with the Latin lower case letter symbols n, u and w.

3.4.2 Kernel-extending-subscripts/indices

In contrast with a descriptive subscript/index by applying a so-called 'kernel-extending-subscript/index' (k-e-index), the dimension of the (original) physical quantity will be changed (slightly). The order of both types of subscripts/indices is as follows (the graphical symbol ' | ' separates the descriptive indices from the kernel-extending-indices):

$K_{\text{k-e-index|descriptive indices}}$

or

$K_{\text{k-e-index|vi;v;iv;iii;ii;i}}$

A kernel-extending-subscript/index can be one of the types vi to i and if more than one k-e-index is necessary the order of these subscripts/indices shall conform to 3.2.2.6.

EXAMPLE By applying descriptive subscripts/indices the dimension of the original physical quantity X does not change, so $< X > \; = \; < X_{|\mathrm{vi};\ldots;\mathrm{i}} >$. But in particular cases the dimension of $< X_{\mathrm{index}|} >$ will be (slightly) altered, so $< X > \neq < X_{\mathrm{vi};\ldots;\mathrm{i}|} >$.

Compare the following physical quantities, viz. the original physical quantity X versus the particular physical quantity X_{index}:

'force' (X) versus 'force per area' (X_{index}) or 'number' (X) versus 'number per year' (X_{index}), etc.

In some cases, for the symbol of the particular physical quantity, this International Standard gives another, new kernel, e.g.:

symbol of the physical quantity 'force': F with $[F]$ = N versus the symbol of the physical quantity 'force per area':

p with $[p] = \mathrm{N/m^2}$.

But in other cases the original kernel will only be changed/extended by a so-called 'kernel-extending-subscript/index', e.g.:

symbol of the physical quantity 'number': n with $[n] = 1$ versus the symbol of the physical quantity 'number per year': $n_{\mathrm{a}|}$ with $[n_{\mathrm{a}|}]$ = 1/year.

In this last example the subscript/index 'a' is mentioned a 'kernel-extending-subscript/index' or the compound symbol 'n_{a}' can be considered as a new kernel.

3.5 Tables

3.5.1 Format of the tables in this International Standard

3.5.1.1 Table 1 General use in the design of structures of types of alphabets

Table 1 in this International Standard is arranged so that it consists of three columns. The first column (from the left) gives the types of alphabets (in combination with upper case respectively lower case letter symbols), the second column gives dimensions and the third column gives common examples and recommendations of physical quantities having that dimension.

3.5.1.2 Tables 2 to 4 of physical quantities

The tables of physical quantities and units in this International Standard (Tables 2 to 4) are - in accordance with ISO 80000 arranged so that the physical quantities are presented in the first 5 columns

